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# The Journal of HEREDITY

*A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics*

ALLEGHENY COLLEGE BIRTH RATE

COLOR INHERITANCE IN CATTLE

PREHISTORIC AND FOSSIL MAIZE

EVOLUTION OF COMPOUND LEAVES

EUGENICS ASSOCIATION MEETS

DOUBLE AND TRIPLE PEACHES

ABNORMAL FLOWER OF WATER LILY

PUBLISHED BY THE
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Volume XIV, Number 2 May, 1923

# SPECIAL NOTICE TO MEMBERS

AS explained in the last issue of the Journal, the reckoning of numbers and volumes has had to be changed on account of a recent ruling of the Post Office Department, which requires the Journal to bear the designation of the current month in order to be mailed as second class matter. Accumulated delays in publication during the war period, which it has been impossible to overcome, resulted in the tardy issuance of the Journal that we must now remedy.

As the most practical way of meeting the difficulty the Council has voted to set membership dues ahead six months, from January to July, and to mark the current issue as the beginning of a new volume, to avoid disturbing the normal relation of the volumes to the calendar years. Although Volume XIV will consist of only nine numbers, it is considered that this inconvenience will be only temporary and cause much less trouble eventually than other ways of adjusting the difficulty.

*The*

# Journal of Heredity

VOL. XIV, No. 2 MAY, 1923

## CONTENTS

THE ALLEGHENY COLLEGE BIRTH RATE..H. R. HUNT 51
A TEXTBOOK OF GARDENING (A Review)..... 60
AN EAR OF PREHISTORIC MAIZE THAT RESEMBLES THE FOSSIL FORM, ZEA ANTIGUA..G. N. COLLINS 61
EUGENICS AND MEDICINE (A Review)..... 64
COLORS OF SHORT-HORN CATTLE...RUSSEL W. DUCK 65
HUMAN CUCKOOS AND HEDGE SPARROWS..... 75
BIOLOGY AND HEREDITY (A Review)..... 76
EVOLUTION OF COMPOUND LEAVES IN WALNUTS AND HICKORIES.....O. F. COOK 77
MEETING OF EUGENICS RESEARCH ASSOCIATION.. 88
TWIN AND TRIPLET PEACHES.....C. H. CONNORS 89
WHEN TO MARRY..... 92
LIVES OF FOSSIL ANIMALS (A Review)..... 92
A REVIEW OF REVIEWS (A Review)..... 93
A FLORAL ABNORMALITY OF THE INDIAN WATER LILY.....P. M. DEBBARMAN 96

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Date of Issue of this Number, May 31, 1923

**NO RACE SUICIDE IN THIS ALLEGHENY COLLEGE FAMILY**

FRONTISPIECE. Not many families of the graduates of Allegheny College were found to be as large as this one. During the thirty-year period studied no marked decrease in the size of the families occurred, but even at the beginning of the period the children of Allegheny graduates were too few to replace their parents. This family could be divided into three "average families" of the group as a whole. When all factors are taken into account, two and a fraction children fall decidedly short of being enough to perpetuate this very desirable element of the population. This finding confirms what other investigators have found to be true of the families of the graduates of the larger colleges, and shows the tendency of this select element of the population to diminish in numbers under existing economic and social conditions. Our institutions of higher learning appear to aid in reducing the proportion of eugenically superior families. No doubt the next suggestion of radical reformers will be to send defectives to college to be sterilized, and keep the good stocks outside to raise families.

# THE ALLEGHENY COLLEGE BIRTH RATE

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THE present study was undertaken to determine whether the modern tendency among educated people to restrict the size of the family has reduced the birth rate among the graduates of Allegheny College. It also adds one more link to the chain of evidence showing that a high state of civilization curbs reproduction among the more intelligent elements of society.

Allegheny College was founded in 1815 at Meadville, Pennsylvania. The present enrollment is about 560 students (men and women). The college has been for years under the patronage of the Methodist Episcopal Church. As a consequence the moral and religious elements in the education of the students have been emphasized. The institution is a good representative of the strong, coeducational, Christian college of the middle west.

The progress, or even maintenance, of civilization depends in part upon the production of a sufficient number of capable and cooperative men and women. There is a difference of opinion, however, as to the effective means of maintaining an adequate supply of them. Some assume that the human mind at birth is a clean slate upon which environmental factors inscribe the symbols of character and capacity. The view which prevails among eugenists, however, is that heredity is fully as potent as environment in framing the course of the individual's physical and mental development. Men are not "created equal." The available evidence supporting this view has been repeatedly presented in the pages of the JOURNAL OF HEREDITY. However, the idea that only environmental agencies shape the human mind, and that heredity has little or nothing to do with moulding it, is so prevalent that a brief and incomplete summary of the evidence may help to clarify the reader's ideas.

## Is Intelligence Inherited?

In the first place, variation is of such universal occurrence among animals and plants that one may regard it as a fundamental property of living things. A large number of these variations is known to be inherited.[1]* If variations in human mental capacity were not inherited, the mind of man would present a very conspicuous anomaly in the realm of life.

Secondly, many physical variations in man are known to be inherited. This fact increases the probability of some mental variations being transmitted, for it shows that man is no exception to the laws of variation. Bell[2] and Pearson[3] (cited from Pearl) have demonstrated that the physical vigor which leads to long life is inherited. Pearson (cited from Pearl) has demonstrated the inheritance in man of variations in stature, span, length of forearm, eye color, cephalic index, and hair color. Huntington's chorea, color blindness, night blindness, exosteoses, polydactyly, skin color, defects in dentation, ichthyosis, haemophilia, and numerous other physical variations from the normal are known to be inherited in man.[4] It is highly probable, in the face of such evidence, that the human brain varies like other organs of the human body, and that some of these variations are inherited. Such variations would express themselves as

*For numbered references, see Literature Cited at end of article.

fluctuations in mental capacity of one kind or another.

Our belief in the variations in human intelligence rests not only upon deductions from the general principle of variation, but also upon direct observations on the human mind itself. Yerkes[5] and his associates organized and conducted a prodigious experiment in mental testing in the United States Army during the World War. A sample, consisting of over 162,000 men, was selected for analysis from the nearly 2,000,000 psychological record cards sent in from the various army camps. The analysis revealed great variation in mental ability. Much of the fluctuation *may* have been due to differences in educational opportunities; part of it was probably caused by inborn differences in ability. This is shown by a comparison between 660 officers, none of whom had gone beyond the eighth grade, with 13,943 native white drafted soldiers of high school or college education. Though the best educated officer in the group had received less education than the least educated recruit, the average rating on examination alpha for the officers was slightly *higher* than that for the recruits. Apparently the inferior training of the officers was offset by an average inborn intelligence superior to that of the recruits.

Goddard[6] has demonstrated the inheritance of feeblemindedness. Degrees of feeblemindedness range from idiocy and imbecility through the higher grades (morons) to types which we would characterize as mentally dull. There is no sharp boundary between the feebleminded and the "normal" categories of persons. Therefore, if the lower ranges of the scale of intelligence are often inherited, why not the higher also? There is no little evidence to support such a conclusion. Galton's classic studies revealed that British men of genius were almost without exception descended from families in which great intellectual ability was the rule.

Frederick Adams Woods in his fascinating book, "Mental and Moral Heredity in Royalty,"[7] has shown that both mental and moral qualities are inherited.

The reader who is interested in examining a very good summary of the evidence that mental capacity is inherited, will find it in Popenoe and Johnson's "Applied Eugenics," chapter 4.[8] Briefly, part of the evidence as presented is as follows:

(1) Mental traits (insanity and feeblemindedness) segregate in successive generations much like other traits which are known to be inherited.

(2) Resemblances in twins persist in spite of differences in the environment; unlike qualities in twins persist in spite of sameness in the environment (Galton).

(3) Older twins do not show greater resemblance than younger ones, though the former have been subjected to the same environment longer than the latter (Thorndike).

(4) Thorndike's experimental work also shows that, "Equalizing practice seems to increase differences. The superior man seems to have got his present superiority by his own nature rather than by superior advantages of the past, since, during a period of equal advantages for all, he increases his lead."

(5) Pearson finds that the average coefficient of correlation with respect to several mental traits in brothers and sisters is about .5. The same degree of resemblance exists for physical traits known to be inherited.

The facts amply justify the view that men differ greatly at birth in their inherited mental endowments, and that these differences exert a profound influence upon their lives.

It is therefore important to determine whether mentally superior stocks are holding their own numerically in our increasing population. If unusually good families die out or decrease it is not probable that their loss can be made good by the substitution of in-

nately mediocre stock, even though educated in the most approved fashion.

### Fecundity and Intelligence

There are indications that the percentage of unusually capable persons is decreasing in the population of the United States.

Regarding the city of Pittsburgh, Johnson, Popenoe, and Scorer[9] report:

"Taking into account all the wards of the city, it is found that the birth-rate *rises* as one considers the wards which are marked by a large foreign population, illiteracy, poverty, and a high death-rate. On the other hand, the birth-rate *falls* as one passes to the wards that have most native-born residents, most education, most prosperity—and, to some extent, education and prosperity denote efficiency and eugenic value."

Cattell[10] in his study of American scientists finds that their marriage rate is high and the death rate for their children is unusually low.

Yet he concludes, "A scientific man has on the average about seven-tenths of an adult son. If three-fourths of his sons and grandsons marry and their families continue to be of the same size, a thousand scientific men will leave about 350 grandsons who marry to transmit their names and their hereditary traits. The extermination will be still more rapid in female lines."*

Cattell shows (Table IX) that 643 scientific men, employed in universities and other institutions, have an average of but 2.28 children each.

Nearing[11] remarks in the course of a study of the birth rates in different sections of Philadelphia, (foot note, p. 635), "Such figures merely confirm in a broad way the fact of common experience—large income, small family, and *vice versa*."

Similar conditions appear to exist in Europe. Bertillon (cited from Holmes,[12] p. 132), studying the birth rate per thousand women between fifteen and fifty years in Paris, Berlin, Vienna, and London, furnishes data which show that the poorer the district of the city, the higher the birth rate.

A statement from Holmes (p. 134) is worth quoting in this connection:

"Several of Pearson's colleagues found in the laboring population of English towns that there was a fairly high correlation between large families and dirty homes (.41), low rent (.31), poor food (.33), insufficient food (.35), low wages of father (.32), and irregularity of employment. We may explain the low rent and the poor and insufficient food of large families as, in part at least, a consequence of their large size. There seems, however, no good reason to suppose that the possession of a large family would have any effect in lowering the wages of the father. Wages are at least a rough measure of the efficiency of the individual worker, and the fact that the men who are poorly paid have a larger number of children than those who receive better wages indicates that the less efficient types have the highest degree of fecundity."

A glance at recent immigration statistics is suggestive. Table I shows the relation between fecundity, mental capacity, and numbers of individuals in this country, of several classes of the foreign-born. The data on birth rates are taken from Holmes.[12] The army mental tests furnish the ratings of average mental capacity of the various classes presented.[5] Classes A and B include the most intelligent soldiers, classes D, D-, and E the least intelligent.

"In general," says Holmes, "The women of native white parentage had 2.7 children, while those of foreign parentage had 4.4."

Without data on death rates it is of course impossible to determine the rates of net increase in these eleven groups.

* About 75 per cent of the graduates of Harvard and Yale marry; and about 50 per cent of the graduates of women's colleges marry.

These observations strongly support the view that some of the highly fecund stocks (Russians, Poles, Italians, etc.), which form a large part of our more than thirteen millions of foreign-born whites, are of comparatively low intelligence. This does not mean that the average intelligence in the particular countries from which these immigrants came is inferior to ours; it may only signify that the poorer material migrates to us.

Such rather unpromising strains are helping to fill the gaps left by the dwindling old American families that have made the country what it is. We should welcome those immigrants who are morally and mentally our equals or superiors; they may bring us strength and stability. But we must be cautious about admitting inferior strains. The whole problem of immigration should be very carefully studied at this time, not by politicians, but by scientifically-minded persons who are competent to discover the facts, and to recommend which types should be admitted and which excluded.

### The Families of College Graduates

Let us turn now to a consideration of the reproductive rate among college graduates. Keeping in mind the fact that mental ability may be inherited, the marriage and birth rates among college graduates are eugenically important, because these persons are undoubtedly above the average mentally. Anyone who has run the gauntlet of the public school and college courses realizes that the vast majority of his schoolmates (not far from 99 per cent according to the report on the army mental tests) drop out of the race before graduation from college. Many leave school, no doubt, for economic or temperamental reasons, but unquestionably a large proportion depart because they are mentally unable to maintain the pace. The army mental tests confirm this view (Part III, Chapter X). The examiners conclude:

"Distinctly more than average intelligence would seem to be a prerequisite to a college education, and almost as strictly a prerequisite to graduation from or even entering high school."

It is disquieting to note, in the light of the facts stated in the last paragraph, that the birth rate in this selected group, college graduates, is comparatively low.

Johnson and Stutzmann[13] have studied the classes of Wellesley College which graduated from 1879-1888. Only fifty-five per cent of the women had married. The number of children per graduate was .86; per wife, 1.56 Such absurdly small families obviously fall far short of replacing the excellent stock from which these girls doubtless came.

Popenoe and Johnson[9] furnish the data for the following citations. The number of children per graduate from Mount Holyoke College has declined from 2.37, for classes graduating from 1842 to 1849, to .95 per graduate for those graduating during the years from 1890 to 1892. Bryn Mawr graduates in the classes from 1888 to 1900 had borne only .37 of a child per graduate by 1913. Sprague finds that of the graduates of Vassar College in the classes from 1867 to 1892, 53 per cent married. There was an average of 1.91 children per married graduate, and but 1.00 child per graduate.

Phillips[14] has studied the birth and marriage rates among the graduates of Harvard and Yale in the classes from about 1850 to 1890. At Harvard the average number of children per graduate has decreased from 1.98 (1861-1870) to 1.55 (1881-1890). At Yale the corresponding data are 2.53 children (1850-1859), and 1.53 (1881-1890).

Banker[15] has demonstrated a decrease of the birth rate in the families of men and women liberal arts graduates of Syracuse University. The average number of surviving children of the women graduates, per graduate, of the classes of 1852 to 1861 was 1.73. This

figure decreased to 1.06 children for the classes graduating in 1872-1881, and to .52 of a child for the period 1892-1901. Likewise the average number of the men graduates' children surviving, per graduate, declined from 2.12 for the classes of 1852-1861, to one child each in the period 1892-1901.

The writer[16] found that better matrimonial ideals prevail among the students of the University of Mississippi than seem to have dominated recently the students in the institutions just mentioned.

The foregoing discussion prepares us for a more intelligent appreciation of the facts bearing on the marriage and birth rates among the Allegheny College graduates.

### Families of Allegheny Graduates

The collection of data presented many practical difficulties. In the first place the college has not preserved adequate records of marriages, and none of births. It was therefore necessary to mail questionnaires to surviving men and women graduates, depending entirely upon their interest and good will for satisfactory replies. The Alumni Register of 1921 furnished the names and addresses and indicated those graduates who had died. A valuable supplementary source of information was a booklet published by the Class of 1890.

A study of the birth rate in such a group would be of little value if the families were not complete, or for the most part nearly so. Hence the class graduating in 1899 was the latest one studied. It was assumed that the ages of the wives in families one of whose consorts graduated not later than this date, would as a rule approach or exceed 45 years, the usual limit of the child bearing period. The collected data accorded with this belief in a general way.

The proportion of deceased members in the classes before 1870 was so large that it was deemed unwise to attempt to study classes of an earlier date.

A questionnaire was sent in January and February 1922, to each of the living graduates of the classes of 1870 to 1899. In April a second copy of the questionnaire was mailed to each person who failed to return the first, with the urgent request that the data be forwarded. This somewhat enlarged the returns, but not enough to warrant a third attempt. Fifty-seven per cent. of all questionnaires were returned. Criticisms based on the incompleteness of our data, however justifiable statistically, should be tempered by the fact that much desirable information was apparently not obtainable by any readily available means.

The essential features of the questionnaire sent to the men are reproduced below. After a brief preliminary explanation, the following questions were asked:

(1) Name.
(2) Are you single, married, divorced, or a widower?
(3) What was your age at graduation from Allegheny?
(4) If married, what was your age at marriage?
(5) If married, how many children have you? Number living ..... .. Number deceased .....
(6) If married, what is your wife's present age?
(7) Supplimentary information or remarks.

The following persons who graduated from Allegheny College in your class are now dead. Please answer the above questions for each one of these deceased classmates, as far as you can do so accurately. Write the information on a separate sheet of paper, or on the back of this sheet.

The women's questionnaire so closely resembled the men's that it need not be reproduced here.

Table 2 shows the total number of alumni, the number living, and the proportion of questionnaires filled out and returned.

Before proceeding to a critical analysis of the marriage and birth rates a glance at some of the raw data may be of interest. These are presented in Table 3.

The discrepancy between the total number of individuals listed in Table

3 (number single plus number married) and the number of questionnaires returned, as shown in Table 2, is due to the fact that the information concerning only the marriage of some deceased graduates was furnished on many questionnaires, and this information has been incorporated in the columns "Number single" and "Number married" of Table 3. Other apparent discrepancies in the number of persons listed in Table 3 are due to the fact that the ages at graduation or marriage of many persons were not given. Information concerning many individuals was fragmentary.

It is evident that during the three decades the per cent marrying, the age at graduation, and the age at marriage remained fairly constant for both the men and the women. The low average age at marriage for the women in the classes of 1873-1879, as well as the great fluctuations in the percentages of childless married women graduates, may be due to the small number of families concerned.

Before indicating the conclusions which logically follow from the analysis of the data, it is necessary to consider some of the data's limitations and peculiarities.

(1) The number of individuals dealt with is small. Consequently, the conclusions arrived at are of general significance only when considered in connection with researches among graduates of other colleges, and among other sections of society.

(2) Sometimes it was not clear whether the number of children indicated included deceased children. The data on children in such questionnaires were not used in the following computations.

(3) The age of the wife in many cases was less than 45 years. Women under that age may have more children. Only sixteen wives were less than 40. Thirty-one ranged in age from 40 to 44. As will be evident later, two series of computations were made: one including all families whose total number of children to date was ascertained, and another using the same data, though excluding all families which may still produce more children.

(4) The 554 living graduates form a group which has survived thus far the ravages of disease. They are doubtless much healthier on the average than their 180 colleagues (24.5 per cent of the individuals of the period studied) who are deceased. Bell[2] has shown that long-lived persons have more children on the average than short-lived ones. Therefore, the surviving seventy-five per cent of the graduates were doubtless more fecund on the average than the whole group of graduates combined.

This view is confirmed in a limited way by the fact that the mean family size was 1.07 children in the families of fourteen deceased male alumni. The total number of children in each family was known. Compare this figure with the families in Tables 5 and 6.

About ninety-four per cent of the married graduates (men and women), whose children are used in our compilations, are living. Hence the fecundity of the married individuals who returned the questionnaires has doubtless, like that of the living alumni in general, been higher than for the whole group of graduates, living and dead. This fact should be kept in mind.

The deaths have naturally been relatively more numerous among the earlier graduates (38 per cent for the period 1870-1884) than among the later (17 per cent for the period 1885-1899). The fact that the number of children per capita is larger in the earlier period than in the later (see Tables 5 and 6) is doubtless due in part to the more highly selected condition of the earlier group.

There is no reason, however, for suspecting that those who returned the questionnaires are any more or any less vigorous physically than those, still living, who did not return them.

(5) It is probable that those who filled out the blanks are more interested, in general, in children than those who did not. A person whose interest in children has never been very great might frequently disregard such a questionnaire as unimportant. Such people are not as likely to have offspring as those who are interested in children. Therefore, there is reason for believing that the number of children per capita reported is larger than it would have been had the whole group of living graduates returned the questionnaires.

(6) A determination of the number of children per graduate would have to be based on a group selected in such a way as to have nearly the same percentages of married and unmarried persons as in the alumni body as a whole, if the determination were to present accurately the facts for the latter. The Alumni Register for 1921 shows that 56.9 per cent of all the women graduates in the period 1870-1899 were married. The percentage of married women (excluding those whose complete family size to date was not given) in the data derived from the questionnaires was 56.2 per cent. When *all* the women reported in the questionnaires (52 married and 32 single) are considered, the percentage of married is 61.9 per cent. This shows that the ratio of married to unmarried women in our sample is not far from the corresponding ratio for the whole group of graduates. It establishes a strong presumption that a similar relation would be found among the men if we had the means (which we do not) of determining the ratio between all the married and unmarried men.

The numerical representativeness of our sample is also indicated by the fact that the percentages of men and women who filled out questionnaires are almost the same as in the whole alumni body of the period studied. The percentage of men is 89.1 in the group returning the blanks, and 87.1 in the Alumni Register, for the period 1870-1884. The corresponding percentages of men for 1885-1899 are 77.7 and 76.6.

In conclusion, the sample studied has doubtless been somewhat more prolific on the average than all the graduates from 1870-1899, and then the living group as a whole. It is representative as far as concerns the ratios between the sexes, and married and unmarried women (probably men too).

We are now ready for an analysis of the facts in the light of the foregoing criticisms. The general conclusions may be summed up in the answers to three questions.

a. Has the marriage rate signifcantly decreased?

b. Has the birth rate diminished significantly?

c. Has the group produced enough children to replace itself?

a. The marriage rate has not significantly decreased, either for the men or the women. See Table 3. Neither has there been any radical change in the age at marriage. The data for formulating the "Per cent married" column for the men in Table 3, were derived from the questionnaires. The Alumni Register for 1921 does not indicate which men are married. The Register does, however, differentiate married from single women. The data for the women in this column were derived, therefore, from the Register. About ninety per cent of the men and fifty-six per cent of the women are married.

Doubtless the difference in the marriage rates between men and women is partly due to a desire on the part of many of the women to enter upon a career, rather than to accept opportunities for marriage.

In only one case (between men of the second and third decades) does the difference between the percentages of married men or women in successive decades exceed the probable error of the difference. In that instance the ratio of the difference to its probable error is 1.07. It is evident that these

data do not show any significant decrease in the marriage rate.

b. There has not been a statistically significant decline in the birth rate among the male graduates concerning whom adequate information was furnished by the questionnaires. The total number of married women, the sizes of whose families were definitely determined, was so small that comparisons of the birth rates in their families have little value.*

Table 4 shows the average number of children per male graduate and per married male graduate by five-year periods. The total number of children to date was ascertained for each of the families represented. Doubtless some of these families, particularly of graduates in the later periods, are not complete yet, for the wives' ages are less than 45 years.

Table 4 shows fluctuations from period to period, but no clear evidence of a general or progressive decrease in family sizes. This conclusion is borne out by the more refined analysis that follows.

The data for the men are massed in Table 5 in two fifteen-year periods instead of six five-year periods. Here again only the families are included in which the total number of children to date (deceased as well as living) was furnished.

*(To be concluded in June number)*

* The full sizes of 27 women's families were ascertained. The 7 women graduating from 1874-1884 had an average of 2.4 children. The 20 graduating from 1885-1899 had an average family of 1.9 children. This computation does not include 14 women who married male graduates, and whose children were therefore included in the determination of birth rates in the men's families.

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[17] Henderson, R. *Mortality Laws and Statistics,* first edition, John Wiley and Sons, New York. 1915. The table used is on page 107.

TABLE 1. *Mental ratings and average number of children in ten foreign-born groups in the United States.*

| Country of Birth | Average number of children per wife | Mental Ratings | | Number in United States, 1920. Census, 1920. |
|---|---|---|---|---|
| | | Per cent D, D-, and E | Per cent A and B | |
| Poland | 6.2 | 69.9 | .5 | 1,139,978 |
| Russia | 5.4 | 60.4 | 2.7 | 1,400,489 |
| Italy | 4.9 | 63.4 | .8 | 1,610,109 |
| Norway | 4.7 | 25.6 | 4.1 | 363,862 |
| Austria | 4.6 | 37.5 | 3.4 | 575,625 |
| Ireland | 4.4 | 39.4 | 4.1 | 1,037,233 |
| Germany | 4.3 | 15.0 | 8.3 | 1,686,102 |
| Sweden | 4.2 | 19.4 | 4.3 | 625,580 |
| Scotland | 3.6 | 13.6 | 13.0 | 254,567 |
| England | 3.4 | 8.7 | 19.7 | 812,828 |
| Whole white draft | | 24.1 | 12.1 | |

TABLE 2. *Data regarding number of Allegheny graduates, and number and per cent of questionnaires returned.*

| Period of graduation | Total number of graduates | | Number of living graduates | | Per Cent living | Questionnaires filled out and returned | | |
|---|---|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | | Men | Women | Per cent combined |
| 1870-1884 | 229 | 34 | 135 | 28 | 62.0 | 82 | 10 | 56.4 |
| 1885-1899 | 361 | 110 | 296 | 95 | 83.0 | 174 | 50 | 57.3 |
| 1870-1899 | 590 | 144 | 431 | 123 | 75.5 | 256 | 60 | 57.0 |

TABLE 3. *Married and single graduates of Allegheny College.*

MEN

| Period of graduation | Number single | Number married | Per cent married | Average age at graduation | Average age at marriage | Per cent* childless marriages |
|---|---|---|---|---|---|---|
| 1870-1879 | 5 | 57 | 91.9 ± 2.4 | 23.1<br>36 persons | 28.1<br>35 persons | 15.0 |
| 1880-1889 | 12 | 123 | 91.1 ± 1.65 | 24.2<br>98 persons | 31.5<br>88 persons | 13.5 |
| 1890-1899 | 19 | 148 | 88.6 ± 1.66 | 23.6<br>136 persons | 29.5<br>130 persons | 19.0 |

WOMEN

| | | | | | | |
|---|---|---|---|---|---|---|
| 1873-1879 | 5[A] | 9[A] | 64.3 ± 8.6 | 20.8<br>5 persons | 23.7<br>3 persons | 0 |
| 1880-1889 | 25 | 30 | 54.5 ± 4.5 | 21.7<br>23 persons | 28.9<br>11 persons | 44.4 |
| 1890-1899 | 33 | 42 | 56.0 ± 3.8 | 22.2<br>38 persons | 27.6<br>24 persons | 21.4 |

* The computation of the percentage is based only on those families in which the total number of children to date is known. The families of women graduates who married Allegheny men graduates are not included in the "Per cent childless marriages" of Women.

[A] Data taken from the Alumni Register for these two columns.

TABLE 4. *Children per married graduate and per graduate.*

| Half Decade | 1870-1874 | 1875-1879 | 1880-1884 | 1885-1889 | 1890-1894 | 1895-1899 |
|---|---|---|---|---|---|---|
| Children per married graduate, where the total number of children in the family is known. | 2.4 | 2.8 | 3.3 | 2.8 | 2.3 | 3.0 |
| Children per graduate. (This computation is based only on single graduates, and graduates in whose families the total number of children is known.) | 2.1 | 2.4 | 2.9 | 2.4 | 2.1 | 2.5 |

TABLE 5. *Children per married male graduate, and per male graduate (married and single.)*

| Period | 1870-1884 | 1885-1899 |
|---|---|---|
| Children per married male graduate where the total number of children in the family is known..... | 80 families<br>2.93 ± .17 | 174 families<br>2.64 ± .10 |
| Children per male graduate. Includes all single alumni reported, and all married alumni in whose families the total number of children to date is known..... | 90 individuals<br>2.60 ± .16 | 200 individuals<br>2.30 ± .10 |

TABLE 6. *Revised table of number of children per male graduate.**

| Period | 1870-1884 | 1885-1899 |
|---|---|---|
| Average number of children per married male graduate.. | 64 families<br>2.95 ± .18 | 112 families<br>2.71 ± .13 |
| Average number of children per male graduate..... | 70 individuals<br>2.70 ± .18 | 126 individuals<br>2.41 ± .12 |

*A final checking of the original data revealed a few comparatively unimportant omissions in the preliminary report which appeared in the program of the American Society of Zoologists (1922). The inclusion of several families of dead alumni lowered the average sizes of completed families to those shown in Table 6. These families, together with the additional inclusion of a few second wives of men graduates, are responsible for the changes from the abstract in the sizes of the parental groups and the number of children produced by these groups. (See Tables 8 and 10.)

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## A Textbook of Gardening

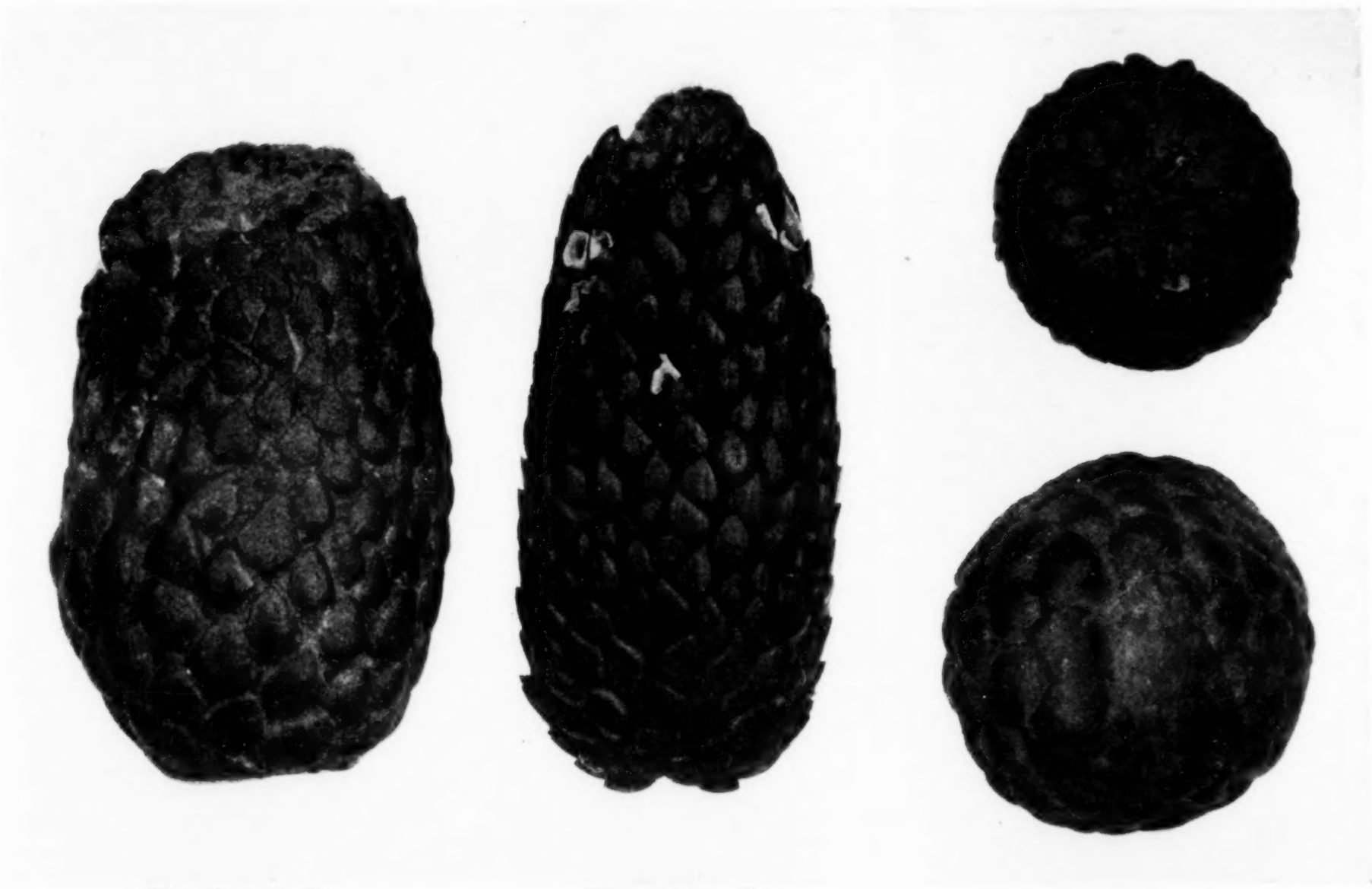
GARDENING, by A. B. STOUT, Director of Laboratories, New York Botanical Garden. World Book Co., New York, 1922.

An elementary textbook on vegetable gardening for use in the grades. This book includes a chapter covering plant breeding and garden seeds. In simple language, is given a discussion of the development of new varieties of horticultural plants using as illustrations corn, tomatoes and the pumpkin. The material included has been carefully selected and effectively presented. It should be welcomed by teachers who wish to give children an appreciation of this side of plant life.—*G. M. D.*

# AN EAR OF PREHISTORIC MAIZE THAT RESEMBLES THE FOSSIL FORM, ZEA ANTIQUA

G. N. Collins

*Bureau of Plant Industry, U. S. Department of Agriculture*



The Fossil Ear The Arica Ear

**PREHISTORIC EARS OF MAIZE**

Figure 1. The Arica ear was taken from a prehistoric grave near Arica, Chile. The fossil ear comes from Peru, although the exact region in which it was found is not known. On the right are the butts of the two ears. The ear-stalks are so small that the ears must either have drooped or been supported by the surrounding leaf sheath. Nearly all of the characters exhibited by these ears can be duplicated in existing varieties of maize—a remarkable demonstration of how little maize has been changed since prehistoric times.

WHEN *Zea antiqua* was described as a new species by Dr. Knowlton[1] it was not found possible to point to a modern variety of maize with ears closely resembling the fossil ear on which the new species was based. Although the fossil ear presented no new characters, no modern variety was known possessing the particular combination of characters exhibited by the fossil specimen. But in view of the great freedom of recombination in the maize plant with respect to all its characters, including those of the ear, no special importance was attached to this failure to find a modern ear duplicating the fossil ear in every particular.[2]

[1] Knowlton, F. H. Description of a Supposed New Fossil Species of Maize from Peru. *Jourl. Wash, Acad. Sci.*, Vol. ix, No. 5, pp. 134-136, March 4, 1919.

[2] Collins, G. N. A. Fossil Ear of Maize. *Journal of Heredity*. Vol. x, No. 4, pp. 171-172, April, 1919.

The close relationship of *Zea antiqua* with modern or recent types of maize is now demonstrated by the discovery of a beautifully preserved ear in a grave near Arica, Chile. The Arica specimen is so like the fossil ear that if the two specimens were contemporaneous they might be referred properly to the same variety. The Arica specimen was unearthed by Colonel John W. Gulick and came to my attention through the kindness of Miss Caroline Rumbold. Colonel Gulick kindly has prepared the following statement of the conditions under which it was found:

> The ear of "maize" was found by me in an Indian grave or tomb in 1913 at Arica, Chile, formerly a part of Peru. My work in Chile was in connection with her Coast Defenses and in mounting a number of 6-inch guns on the "Morro" of Arica (a cliff rising about 250 meters out of the sea), it was necessary to take the guns up by means of a zig-zag track of light rails laid on the land side of the cliff. During these operations we ran into a large group of graves or tombs which were in an excellent state of preservation due to the climatic conditions and the presence of crude nitrate in the soil. As you are doubtless aware, this is an extremely arid area. The Chilean soldiers, knowing that I was interested in the history of the ancient people, assisted me in securing quite a collection of pottery, implements, toys, fabrics, etc., from these tombs. Each body was provided with a bag which contained a collection of small pots or vessels for food or drink. In some, quantities of cocoa leaves or "mate" would be found. The ear of "maize" was found in one of these bags.

The country about Arica has practically no rainfall, and maize is not now grown in that region. Remains of irrigation works indicate that streams arising in the mountains formerly were diverted and used for the growing of crops.

The Arica ear (see Figs. 1 and 2), is somewhat smaller than the fossil, which is incomplete, but presents practically the same characteristics. It has small, pointed grains, irregularly disposed in approximately 20 rows. The grains are borne over the entire base of the ear which is somewhat enlarged as in the fossil and the ear stalk must have been extremely slender. Existing varieties with such small grains usually have an endosperm that is almost completely corneous and are classed as pop corns. Unless age has changed the nature of the endosperm, however, the prehistoric ear is not a pop corn, for the seeds now are filled with soft starch, the starch grains being spherical. We never before have seen a variety of soft corn with seeds so small as those of the Arica and the fossil ears.

An examination of the endosperm of the maize from Arica was made by Dr. E. H. Toole, who found it to be true starch, staining blue or purple with iodine.

Since the fossil ear undoubtedly represents the earliest type of maize of which we have knowledge, it may be of interest to examine the type as interpreted by the Arica specimen and call attention to such characters as may be considered primitive.

*Size*: The Arica specimen, which is somewhat smaller than the fossil ear, also is smaller than the ears of any commercial variety except some of the pop corns. Commercial varieties with small ears have also small plants, a general reduction in size having accompanied selection for earliness. Many of these small varieties are very efficient and produce a large amount of grain in proportion to their total weight.

Small ears, therefore, may not be considered primitive unless they are borne on relatively large plants. There is at least one variety from Peru with ears as small as the Arica specimen and with plants over two meters in height.[3]

*Shape*: The tapering form of the ear is perhaps a primitive character, since in this rather extreme degree it

[3] An ear of this variety is shown natural size as Nos. 5 and 6 of Fig. 7. *Journal of Heredity*, Vol. x, No. 4, p. 171, April, 1919.

**THE ARICA EAR AS FOUND IN A PREHISTORIC GRAVE**

FIGURE 2. The grave was excavated in the face of a cliff on the coast of Chile, in a region where no maize is grown today because of extreme scarcity of water. Remains of irrigation works indicate that the ancient inhabitants brought water for their crops from the distant mountains. This region gives evidence of having been the home of a numerous prehistoric people, but just how long ago they lived is not known. When the Spaniards arrived the coast of Chile was as much a desert as it is today.

is found only in unimproved varieties grown by native tribes. Many of these, however, have ears fully as tapering as in the prehistoric form. On the other hand, the rounded butt with grains extending over the base of the ear usually is considered a mark of good breeding. The strikingly small ear stalk of both the fossil and Arica specimens is a character much desired in commercial varieties on account of the ease in shucking, and no existing variety is known with ear stalks so slender as those of the fossil and the Arica specimens.

*Number of Rows*: The large number of rows of spikelets on the ear and the central spike of the tassel is one of the most striking characters that separate maize from all related grasses. It would be expected, therefore, that a truly primitive form would have a small number of rows. In modern varieties the number ranges from eight to something over thirty but it is not certain that the eight-rowed types are more primitive or less highly specialized. Eight-rowed varieties are most common near the northern limit of the geographic range of maize and where they reappear in South America it is in connection with the highly specialized, large-seeded Cuzco and related varieties grown at relatively high altitudes.

The irregular arrangement of the grains in both specimens makes it impossible to determine accurately the number of rows. There are, however, at least twenty in the Arica specimen and probably twenty-two in the fossil ear. These numbers are well above the average of modern varieties.

*Arrangement of Grains*: The lack of regularity in the arrangement of the grains may be considered a primitive character if the ear is assumed to have originated by the shortening and twisting of a four-rowed spike. But if the ear originated through the fasciation of lateral four-rowed branches the irregularity must represent a specialization of the original form. Irregularly disposed grains are a common variation in many varieties but are characteristic of none except the sweet variety, "Country Gentleman," where the irregularity is due to the development of both of the flowers of the spikelet. In the Arica specimen only one flower is developed in the spikelet.

*Size of Grains*: The grains are small but not smaller than in many varieties of pop corn. Since the endosperm of the Arica specimen is composed of soft starch the specimen may not be called a pop corn and since these specimens represent the smallest grains with soft endosperm the small size perhaps may be looked upon as primitive.

*Shape of Grains*: Grains with such a pronounced point or beak are rather unusual except in the pop corns. The resemblance to pop corn varieties in the shape of the grains probably is accidental, a closer relationship being with the large-seeded, soft varieties with beaked grains common in South America. Although very sharp, the beak is less pronounced than in some of the Bolivian varieties and these prehistoric forms may represent the beginning of this specialization.

There are no characters of these early ears that suggest the pistillate spike of teosinte, the nearest wild relative of maize, more closely than existing varieties of maize. The small ear stalk, the irregular arrangement of the grains and the soft endosperm associated with small grains are the only characteristics not included in the range of modern varieties.

While the Arica specimen may not be said to throw much light on the development of maize it serves to link the fossil specimen more closely with existing forms and gives added proof of the great permanence of the germ plasm of maize. It further emphasizes the fact that all the important steps in the domestication of maize took place at least as early as the period represented by the fossil ear.

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## Medical Eugenics

DIE PATHOLOGISCH - ANATOMISCHEN GRUNDLAGEN DER FRAUEN-KRANKHEITEN, 24 Fortbildungsvortraege aus dem Gesamtgebiet der Gynaekologie, by DR. WILHELM LAHM, Director of the Laboratories of the Municipal Woman's Clinic of Dresden. Pp. 301; 71 illustrations. Price, $1.40. Dresden und Leipzig, Verlag von Theodore Steinkopff, 1923.

The increasing prevalence of childlessness among American married women has often been remarked. Frederick S. Crum found that the percentage, in the old native-born stock, increased from 1.8 in the last half of the 18th century, to 8.10 in the decade 1879; while J. A. Hill, analyzing the figures of the 1910 census, showed that one in eight native-born wives is childless, as compared with one in five negresses and one in nineteen of the foreign-born. Much of this childlessness is voluntary, but an important part of it is not. Every reader will know, in his own circle of acquaintances, a number of married couples who desire children, and who, from a eugenic point of view, ought to be parents, but are not. The cause in many cases is wholly a mystery, and efforts to clear up this mystery form a very definite contribution to practical eugenics, just as does all progress of obstetrical science toward more painless childbirth. Neither of these lines of research has received as much attention as, from a eugenic point of view, it deserves, but in recent years a number of competent men have published books throwing some light on the causes of childlessness; the work under discussion is an admirably organized and clearly written one. While the study of sterility in the male is relatively simple and easy, gonococcus infection being the usual cause, investigation of barrenness in the female is, for obvious reasons, exceedingly complicated and difficult. Every step forward in this investigation should be welcomed by eugenists. —P. P.

# COLORS OF SHORT-HORN CATTLE

## Analysis of Genetic Factors Underlying Color Inheritance In Short-Horn-Cattle

RUSSELL W. DUCK

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TO WRITE a definite formula that would fit all cases of Short-Horn color inheritance is very difficult. The problem is complicated by the number of different recognized colors: red, red and white, roan, and white. It is also difficult to secure accurate data from the herd books, because of the occasional blending of these colors into one another, thus giving conflicting ideas of the color in question. This is influenced to some extent by the popularity of the color. Plumb[1] gives the relative proportion of the different colors of Short-Horns at two different periods, as shown in Table I. The author computed the colors of part of the animals registered in the herd book in 1921. The records of a total of 10,000 animals were studied and the results obtained are shown in the last column of the same table.

These tables show the decreasing popularity of red-and-white. The gradual elimination of herd bulls of this color is having a considerable influence on the total number of red-and-whites registered. The increasing popularity of roans, and the frequent selection of roan or white herd bulls has materially increased the number of roans registered in 1921 as compared with those registered in 1859 and 1914.

In attempting to trace color inheritance from the herd books one is immediately confronted by the fact that sources of error are probably very frequent. Exact color classification is extremely difficult; occasionally animals could be classified either as roan or as red-and-white (see Fig. 3.)

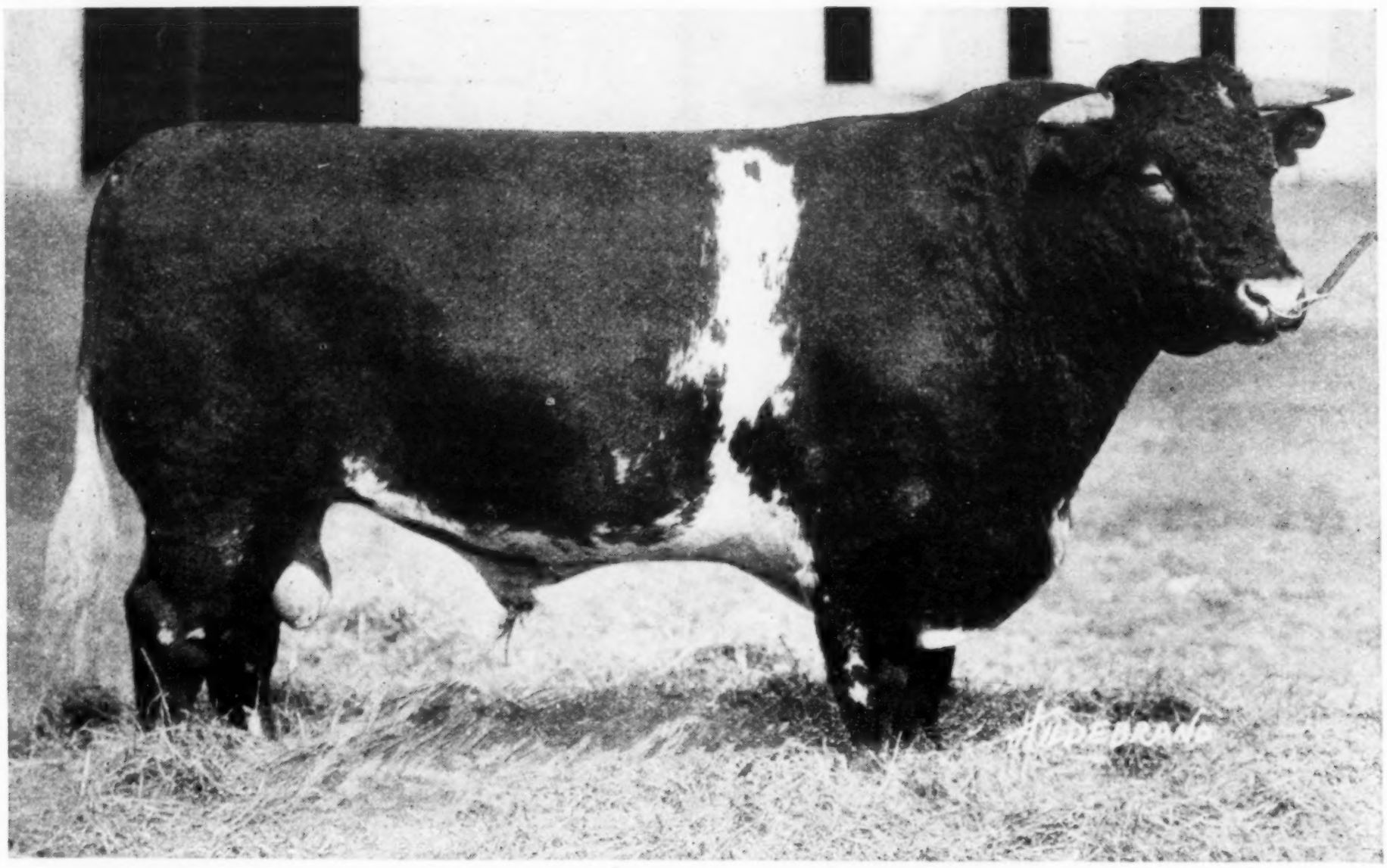
Secretary P. K. Groves of the American Short-Horn Breeders' Association states that the rule of the Association is to call all cattle roans if there is roan coloring on any part of the body.

According to Darwin[2], the wild white cattle of Europe did not breed true, and occasionally produced colored calves, although these individuals were never retained in the breeding herd. In this respect the inheritance of white is different from that in the Short-Horn. A true white Short-Horn mated to a true white Short-Horn will produce only whites. It is true that Wentworth[3] presents cases of four reds and eight roans produced from a cross of white on white out of 153 matings. However, this is entirely within the probable limits of error. In tracing 186 matings of white on white, visiting and corresponding with doubtful cases, no case of true red, roan or red-and-white was established.

It was also established that red Short-Horn cattle breed true. In tracing 2567 matings of this character no case of pure white offspring was established from true red on true red. In cases where colors other than red are recorded in offspring as a result of crossing red on red, it will invariably be found that one or both of the parents were marked with white or else that the offspring is incorrectly registered.

The so-called "colors" roan and red-and white of the Short-Horn are,

[1] Plumb, "Types and Breeds of Farm Animals". (Revised Edition).
[2] Darwin, "The Variation of Animals and Plants Under Domestication."
[3] Wentworth, *American Breeders' Magazine*. Vol. IV, No. 4.



**REGISTERED AS A ROAN**

FIGURE 3. According to the rules of the Short-Horn Breeders' Association, an animal which exhibits roaning on any part of the body may be registered as a roan. Since this is a more popular color than red and white, animals which can be entered as roans are generally so recorded. When roaning occurs on only a small part of the body, as in this case, the animal is assumed to be heterozygous for the extension factor which differentiates the roan pattern from the red and white. This animal is not of the same genetic constitution as the pure roan shown in Figure 4. The pedigree of this animal is given below.

PEDIGREE OF ROSEWOOD RADIUM 512686—ROAN

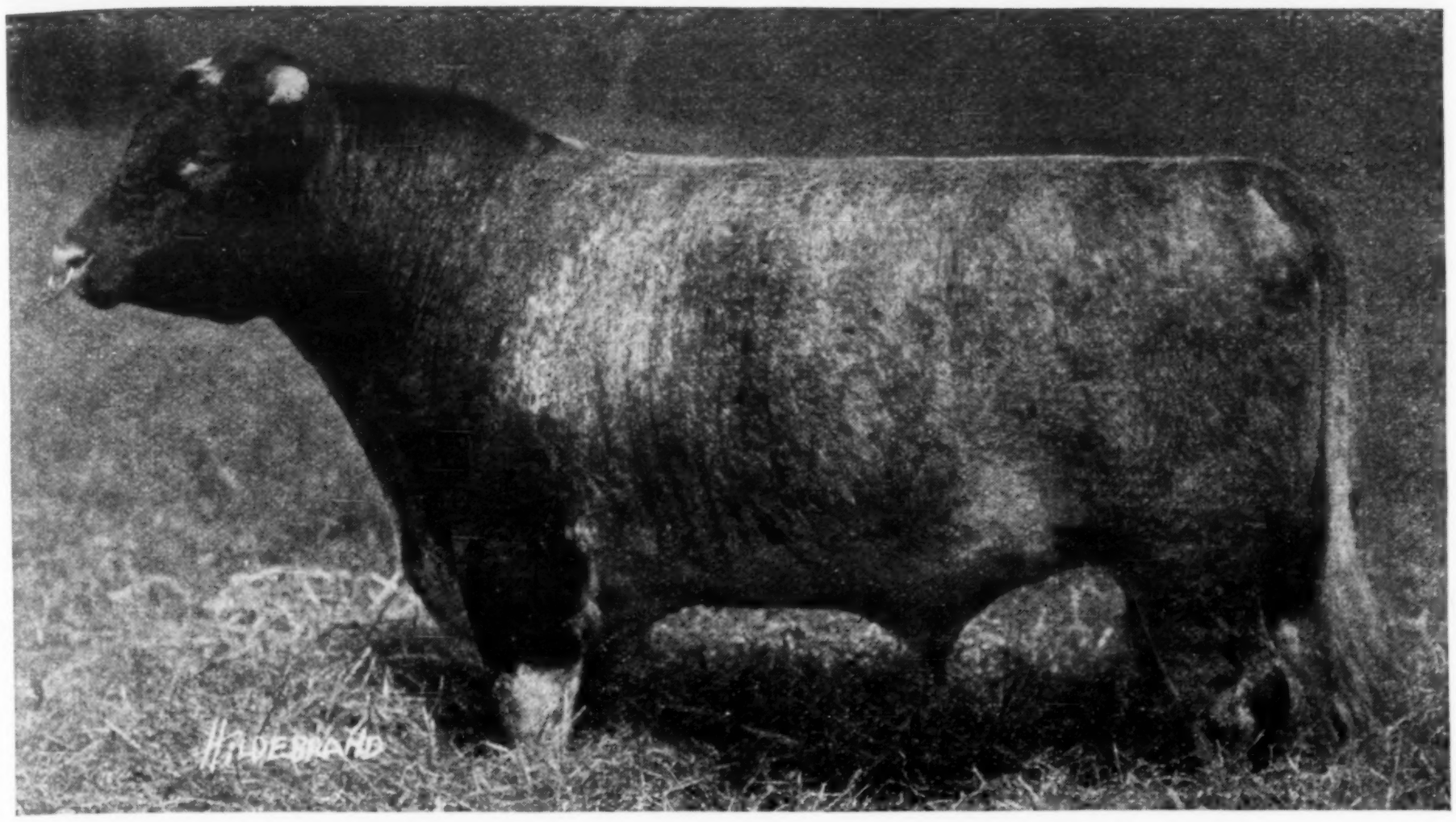
| | | |
|---|---|---|
| **Sire** | Radium 385197 White | Double Dale 337156 Roan<br>Lady Fragrant Roan |
| **Dam** | Crestmead Rosewood 129176 Red | Scottish Goods 292932 Roan<br>Rosewood 87th Roan |

genetically speaking, not separate colors at all, but are obviously a rearrangement of the two colors red with white just discussed. The question of an individual becoming a roan or red-and-white must then depend on the introduction of an extension factor, which we may designate by (E).

Taking the red color as the basis of all combinations it can be represented as a definite color factor (R). The total absence of (R) gives a white individual. White, then, in Short-Horns, is not genetically speaking, a color, but is caused by the total absence of (R) and can be genetically represented as (r).

The Iowa Station[4] gives results from crossing a white Short-Horn bull on pure-bred Galloway cows, with the following results: Twenty-seven blue-gray, and one red-roan. The same bull on grade Galloway cows produced twenty-six blue-gray, one black (attributed to

[4] Jones and Eward, *Iowa Research Bulletin*, No. 30.




**NAEMOOR BRIDEGROOM—A TRUE ROAN**

FIGURE 4. Animals "pure," for the extension factor, i. e., those which inherit the extension factor from both parents show the roan pattern over a large part of the body. The largest percentage of roans is produced by crossing red animals and white ones.

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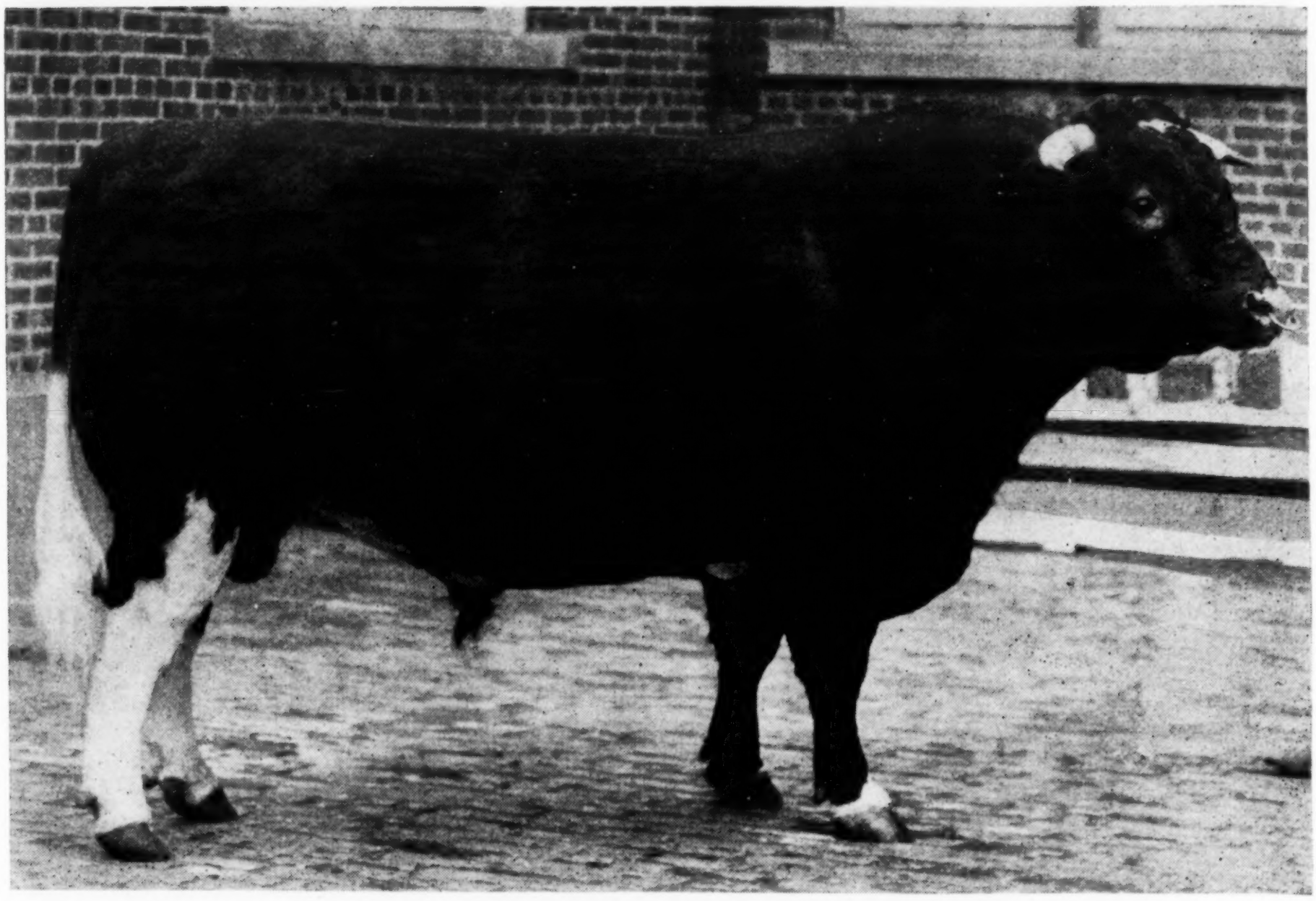
Pedgree of Naemoor Bridegroom
BRED BY

| | | | | |
|---|---|---|---|---|
| Sire: Edgecote Masterpiece 725931. White | Bletchley King 409039. Roan | Silver Mint 323662. Roan | Silver Plate 145554 White- | |
| | | | Mistletoe 16th V45-934 Red- | |
| | | Lancaster 42nd V53-926E. Red, Little White | Bright Stone 409047. Roan- | |
| | | | Lancaster 41st V53926E. Red- | |
| | Lady Mabel V57-6906. Roan | Pride of Avon 311139 Roan. | Primrose Pride 222709 Roan- | |
| | | | Rose Blossom V45-4892. Red- | |
| | | Mabel 6th V57-9412. Red | Bacchus of Dalmeny 306266. Red- | |
| | | | Mabel 3rd V38-518E. Roan- | |
| Dam: Miss Helen 891231 Red. | Cupbearer 679630 Red | Collynie Cupbearer 610496 Red. | Jubilant 609047 Red. | |
| | | | Collynie Princess 4th 557676 Roan- | |
| | | Boguhan Claret V54-938E. Roan | Proud Monarch 317044. Red- | |
| | | | Nora 2nd V54-938E. Roan- | |
| | Stella 2nd 725937 Red. | Earl of Elgin 680234 Roan | Prince of Sanguhar 149558 White- | |
| | | | Eliza 16th 679390 Red | |
| | | Estella 6th 725934 Red | Dorset Prince 680488. Red- | |
| | | | Estella 725933 Roan | |



**REGISTERED AS RED**

FIGURE 5. The presence of a little white on the belly and legs indicates that this bull is genetically red-and-white, but, since the former color predominates, he is registered as red. His pedigree is given below.

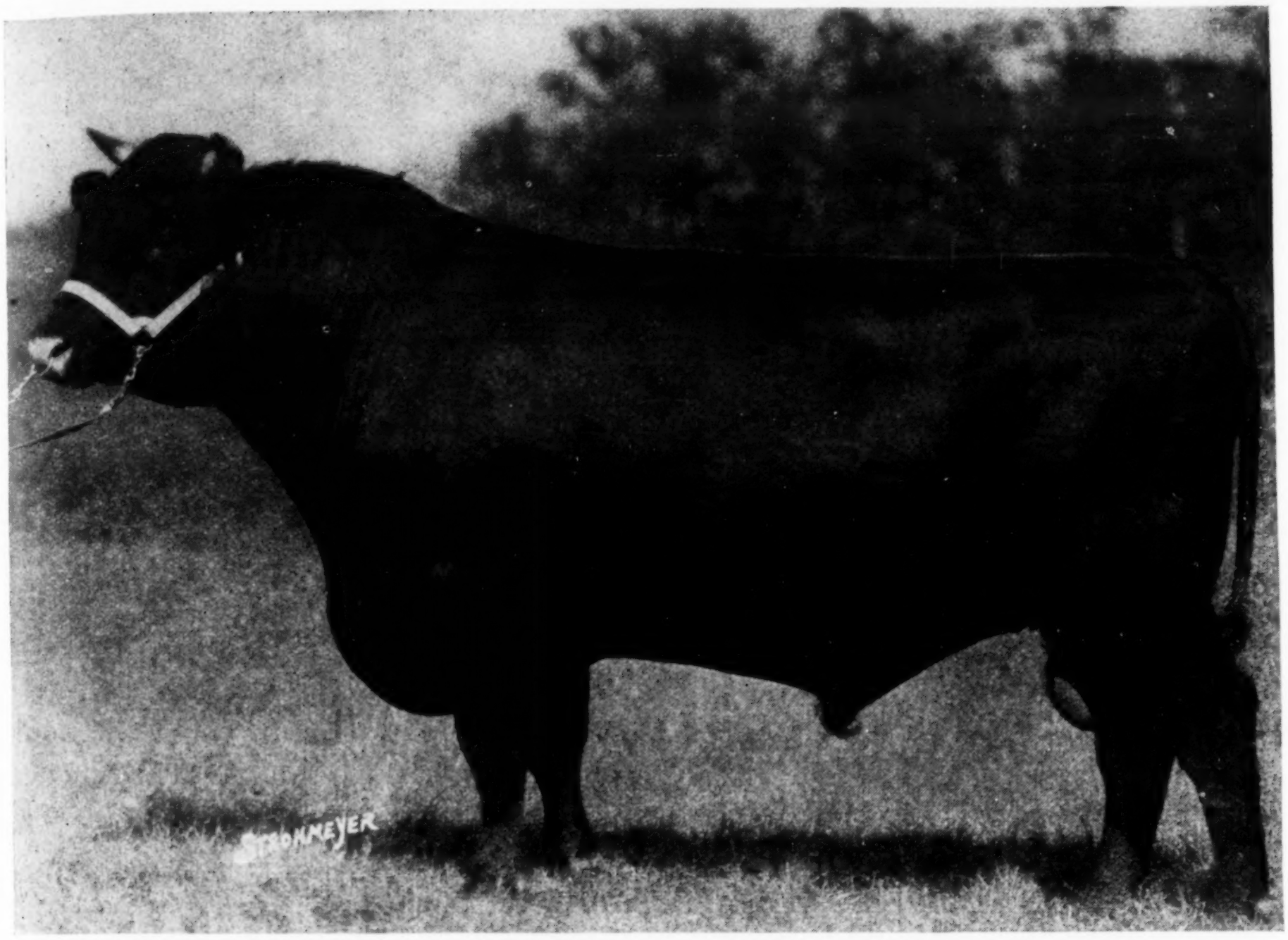
PEDIGREE OF DIAMOND GOODS 333014—RED

| | | |
|---|---|---|
| **Sire** | Good Choice 227852 Roan | Choice Good 186802 Roan<br>Silence 2nd V45-1263 Red |
| **Dam** | Sweetheart 13925 Red | Victor Allan 212209 Red<br>Modesty Red |

incorrect recording), six red-roan and two red calves. No black-and-white individuals appeared. As roans do not appear from crossing pure black on pure black, this mating indicates the roan extension factor (E) was carried by the white bull, and that he was also heterozyous for this factor. On the basis of this cross an assumption is possible that the roan extension factor (E) is associated with white in Short-Horns.

J. Wilson[5] assumes that red crossed on white will always produce a roan. This apparently does not hold true in Short-Horns. Whitehall Sultan, a famous white Short-Horn bull, sired many calves out of red cows which are recorded as reds. These so-called reds, though, are carriers of a little white

[5] Wilson, "Mendelian Characters Among Short-Horn Cattle." *Sci. Proc. Roy. Dub. Soc.*, 11.




**GENETICALLY PURE RED**

FIGURE 6. Pure reds bred to pure reds should always produce offspring of the same color. The contradictory results sometimes obtained from using the data contained in the herd books of the cattle breeding associations are caused by the classification as red of such animals as that shown in Figure 5. Genetically the two animals are not the same, and this fact would be shown by differences in the color of their offspring.

PEDIGREE OF DUKE OF GLENSIDE 813884—RED

| | | |
|---|---|---|
| Sire | General Clay 255920<br>Red and White | Duke Buttercup<br>160769 Roan<br>Mamie Clay 2nd<br>V48-342 Red and White |
| Dam | Lady Favorite (Imp.)<br>634158 Red | Coral Favorite<br>634157 Roan<br>Lady Grace<br>593355 Roan |

and genetically are really red-and-whites. Tracing 1743 matings of this character, almost fifteen per cent of them were registered as red-and-white (See Table III). The logical genetic explanation for the appearance of these individuals is a heterozygous condition of the white parent for the roan extension factor (E). The absence of black-and-white individuals appearing in the Iowa work is due to the fact that the black of the Galloway acts differently than the red of the Short-Horn toward assuring a pied pattern in the phenotype; this is probably due to the presence of some inhibiting factor associated with Galloway black.

That the red of the Short-Horn can also carry the roan extension factor is

**A TRUE RED-AND-WHITE**

FIGURE 7. The red-and-white pattern is due to a cross between the two colors in the absence of the extension factor, the factor which produces roaning. Of late years this pattern has lost favor among cattle raisers.

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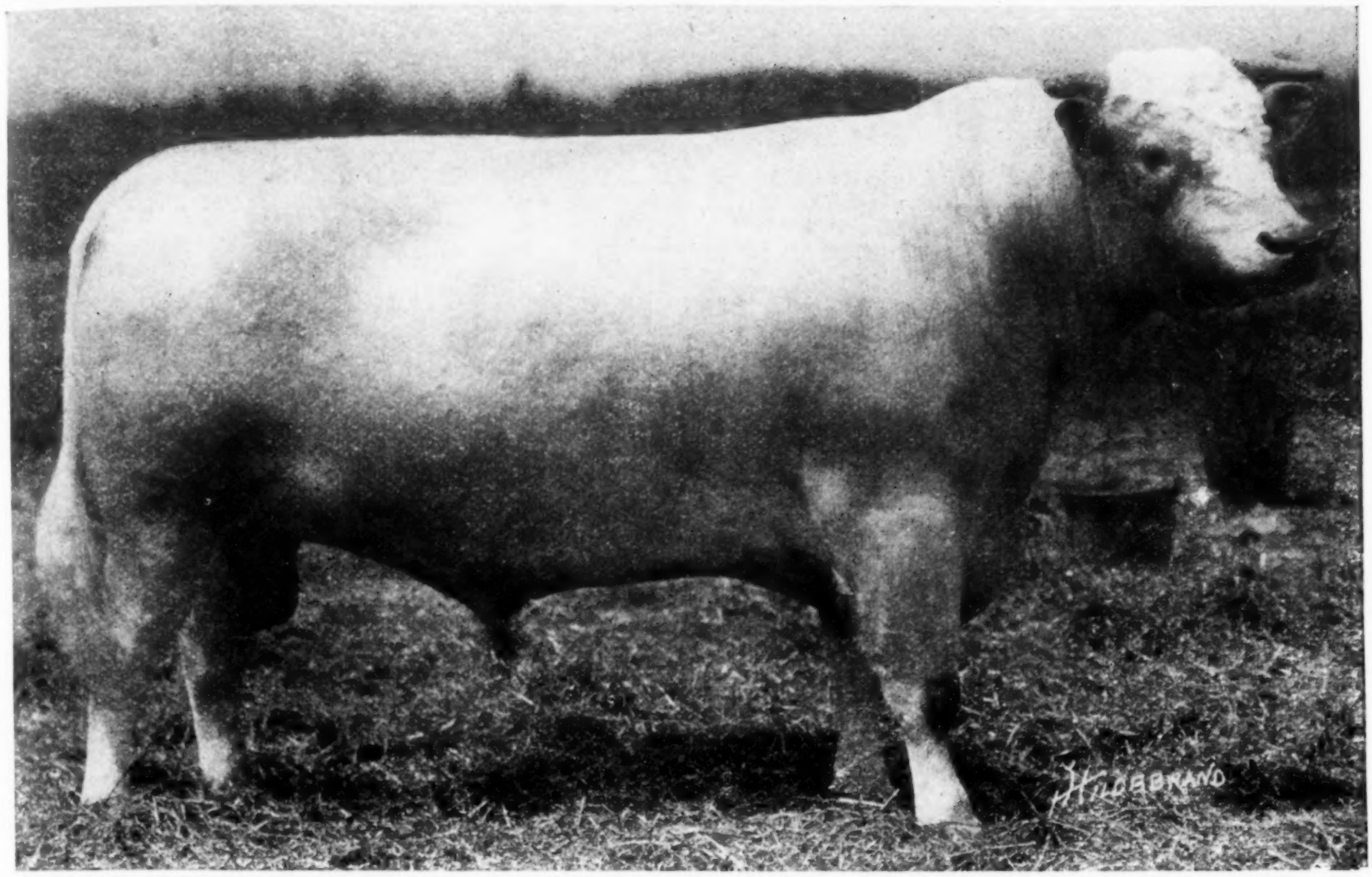
PEDIGREE OF AUGUSTA STAMP 920676—RED AND WHITE

| | | | | |
|---|---|---|---|---|
| **Sire** | Regal Stamp 396730 White | Sultan Stamp 334974 White | Whitehall Sultan 163573 White | Bapton Sultan 163570 Roan<br>Bapton Pearl V48-368 Roan |
| | | | Rachel's Daughter (Imp.) V62-747 Roan | Daybreak 182751 Red<br>Dolly V47-415E Roan |
| | | Autumn Rose V68-709 Roan | Good Morning 182755 (dark) Roan | Joy of Morning 153003 Roan<br>Vain Belle 2nd (Imp.) V46-168 Red |
| | | | Queen of the Herd V61-901 Red | Sovereign 157380 Red<br>Cherry Grove Queen V49-857 Red |
| **Dam** | Augusta 110th 121392 Roan | Lord Lancaster 270685 Red | Lord Mistletoe 228949 Red, little White | Lovat Champion 157617 Red<br>Mistletoe 3rd V45-434E Roan |
| | | | Lancaster Pet (Imp.) V46-140 Red | Scottish Emblem 144668 Red and White<br>Lancaster Fame V45-402E Roan |
| | | Norwood Augusta 4th 38087 Roan | Annabella's Knight 224286 Red | Crescent Knight 180433 Roan<br>Annabella (Imp.) V47-102 Red |
| | | | Norwood Augusta 2nd 38085 Roan | Crescent Knight 180433 Roan<br>Augusta 105th (Imp.) V47-102 Red and White |




**NEWTON CHAMPION—A WHITE SHORTHORN**

FIGURE 8. Red in Short-Horns is the only basic color, and white appears to be due to total absence of red. Red-and-white and roan individuals are the result of the red color factor being in heterozygous or dilute condition.

PEDIGREE OF NEWTON CHAMPION 650059—WHITE

| | | | | | |
|---|---|---|---|---|---|
| Sire | Grand Champion 616773 Roan | Champion of Scotland 387167 Roan | Newton Crystal 340775 White | Opal Stone 340776 Roan | |
| | | | | Chrystaline V49-562E Roan | |
| | | | Nellie 8th 614634 Red | Baron Lavender 387164 Roan | |
| | | | | Nellie 6th 614633 Red | |
| | | Golden Wreath 17th V57-593E Roan | Willie Campbell 646486 Red | Royal Victor 93286 Roan | |
| | | | | Pride of Rothes 803957 Red | |
| | | | Briar Bud V57-593E Roan | Spion Kop 266466 Red | |
| | | | | Golden Wreath 7th V46-409E Roan | |
| Dam | Newton Molly 2nd 650063 Roan | Newton Crystal 340775 White | Opal Stone 340776 Roan | Corner Stone 150676 Roan | |
| | | | | Orchid Blossom V45-468E Roan | |
| | | | Chrystaline V49-562E Roan | Crystal Star 340772 Roan | |
| | | | | Lady Fragrance 9th V49-8222E Red | |
| | | Lady Molly 650062 Red | Corner Stone 150676 Roan | Touchstone 149631 Red and White | |
| | | | | Butterscotch V41-395E White | |
| | | | Lady Madge 650060 Red | Lord Chamberlain 342978 Roan | |
| | | | | Lady Maud 650061 Red | |

unquestionably proven by the results obtained from the various matings in Table III. The question logically arises, why will a cross between red and black produce no roans? The reason is apparent when it is considered that red and black are genetically, as well as practically, true allelomorphs, resulting in complete dominance of black in the heterozygote. Which in turn will separate out in the second generation in the definite Mendelian ratio of three dominants to one recessive. This has been proven too often to need further discussion. It will serve, though, to show that the red of the Short-Horn may be often associated with the roan extension factor (E), but its presence will not be proved as it will not be brought to light in the phenotype.

Many of the apparent contradictions which occur in the various color matings of Short-Horns can be eliminated if it is assumed that red-and-white in the Short-Horn is not caused by the introduction of an extension factor entirely different from roan (E), but is really produced by the total absence of E and can be represented as (e). When this occurs in the presence of a heterozygous condition for red (R) a red-and-white animal is produced.

A logical basis has now been established for assuming genetic formulae for the various phenotypes, viz:

$$\text{Red} = \begin{cases} \text{RRee} \\ \text{RREE} \\ \text{RREe} \end{cases}$$

$$\text{Roan} = \begin{cases} \text{RrEE} \\ \text{RrEe}^{6} \end{cases}$$

$$\text{White} = \begin{cases} \text{rrEE} \\ \text{rrEe} \\ \text{rree} \end{cases}$$

$$\text{Red-and-White} = \begin{cases} \text{Rree} \end{cases}$$

The average mathematical possibilities of segregation from all possible mating combinations are given in Table III.

### Apparent Contradictions Explained

Apparent contradictions are not so great as would seem at first glance; a comparison of theoretical possibilities with actual recorded results are given in Table III. It is obvious that the greatest source of error is the registration of red individuals. The recording or twelve per cent red-and-white, three per cent roan and one per cent white from this mating is sufficiently close to the theoretical possibilities to be within the limits of probable error. One or both the parents in these cases must have been genotypically red-and-white, but the pattern in the phenotype showed so great a preponderance of red that the individual was recorded as a red (see Figure 5).

The appearance of such individuals as *Rosewood Radium*, which shows a phenotype carrying both roan and pied pattern, can be explained by assuming they have a genetic makeup of (RrEe), with respect to the colors in question. A true roan of the genetic form (RrEE) is shown in Figure 4. On this hypothesis if mated to (RrEE) he would sire no true red-and-whites of the formula (Rree).

Theoretically a true red-and-white (Rree) such as is shown in Figure 7, crossed on (Rree) cows will produce no roans. Actually between five and ten per cent roans are recorded as resulting from matings of red-and-white on red-and-white. This is possible, when it is considered that animals having the zygotic formula (RrEe) may be recorded as red-and-white. Matings of (RrEe) and (Rree) would allow theoretical possibilities of twenty-five per cent roans. In figuring the percentages in Table II no allowance could be made for this probable source of error,

[6] RrEe is usually recorded as roan, as the American Short-Horn Association rules that an individual may be recorded as a roan if roaning appears on any part of the body. However, no doubt many RrEe individuals are recorded as red-and-white.

because it would seem unlikely that (Rree) and (RrEe) would occur in equal ratio. In fact, the preponderance of data shows that whenever possible (RrEe) individuals are registered as roans because of the greater popularity of this color over red-and-white.

### Practical Aspects

1. The crossing of red on white will both theoretically and actually give the highest percentage of roans. Crossing roan on white will give the next highest percentage of roans. Red on roan, red-and-white on roan, roan on white, and roan on roan will all give about the same percentage of roan calves, approximately forty per cent.

2. To produce a strain of roan Short-Horns which will breed true for roan seems impossible from both a practical and theoretical standpoint.

3. A few isolated cases should not be used as a guide or to draw conclusions from. Several hundred cases should be traced to come to any definite conclusion.

4. Color pattern seems in no way to be correlated with sex in Short-Horns. A red bull crossed on white cows will produce as many roans as a white bull on red cows. Sufficient individuals to establish a fair average must be used.

5. Genetically there are three kinds of red and three kinds of white Short-Horns. This will account for many of the apparent contradictions in Short-Horn color mating.

6. Pure red on pure red will produce only red. Pure white on pure white will produce only white.

7. White in Short-Horns is due to the total absence of any color factor.

8. Red is the only real basic color in Short-Horns.

9. Red-and-white is due to a dilution of the red color factor, in the absence of the roan extension factor.

10. Roan is not a separate color, but is a blending of red and white due to the presence of an extension factor in the germ cells of one or both parent types.[7]

Table I. *The relative proportions of the various recognized colors of Short-Horn cattle in the United States at three different periods.*

Data for the years 1895-1914, inclusive, is taken from Plumb's *Types and Breeds of Farm Animals*, by permission of Professor C. S. Plumb. That for 1921 was compiled by the author.

| Color | 1895-1903 Number | 1895-1903 Per cent | 1910-1914 Number | 1910-1914 Per cent | 1921 Number | 1921 Per cent |
|---|---|---|---|---|---|---|
| Red | 4,943 | 49.43 | 15,085 | 62.85 | 4,959 | 49.59 |
| Red and White | 2,748 | 27.48 | 3,540 | 13.93 | 1,114 | 11.14 |
| Roan | 2,034 | 20.34 | 5,072 | 21.13 | 3,532 | 35.32 |
| White | 275 | 2.75 | 503 | 2.09 | 395 | 3.95 |
| Total | 10,000 | 100.00 | 24,000 | 100.00 | 10,000 | 100.00 |

Table II. *Percentage of Color Segregation in the Zygote.*

| | | Red | Red and White | Roan | White |
|---|---|---|---|---|---|
| 1. Red × Red = | {RREE, RREe, RRee} × {RREE, RREe, RRee} = | 100 | 0 | 0 | 0 |
| 2. Red × R. and W. = | {RREE, RREe, RRee} × Rree = | 50 | 25 | 25 | 0 |

[7] The author wishes to acknowledge the assistance and co-operation given by the American Short-Horn Breeder's Association through their secretary, P. K. Groves. Also to the assistance given by Mr. A. W. Lathrop and Mr. Herbert Comstock, of Syracuse University. To the many breeders and herdsmen consulted the author wishes to express his appreciation and thanks.

Table III. [1] *Segregation Table of Short-Horn Colors. Tabulated from Matings Traced in the American Short-Horn Herd Book. A Comparison of Actual Recorded Results with Theoretical Possibilities.*

| Matings | Number Traced | Percentage of colors produced in Offspring | | | | | | | | | | | | | | | | Total % | Total Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Red | | | | Red & White | | | | Roan | | | | White | | | | | |
| | | Recorded | | Theoretical | | Recorded | | Theoretical | | Recorded | | Theoretical | | Recorded | | Theoretical | | | |
| | | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | | |
| 1. Red × Red | 2,567 | 84 | 2,156 | 100 | 2,567 | 12 | 308 | 0 | 0 | 3 | 77 | 0 | 0 | 1 | 26 | 0 | 0 | 100 | 2,567 |
| 2. Red × Red-and-White | 446 | 47 | 210 | 50 | 223 | 31 | 138 | 25 | 112 | 20 | 89 | 25 | 111 | 2 | 9 | 0 | 0 | 100 | 446 |
| 3. Red × Roan | 3,218 | 50 | 1,609 | 50 | 1,609 | 10 | 322 | 8 | 257 | 39 | 1,255 | 42 | 1,352 | 1 | 32 | 0 | 0 | 100 | 3,218 |
| 4. Red × White | 1,743 | 1 | 17 | 0 | 0 | 14 | 244 | 25 | 436 | 83 | 1,447 | 75 | 1,307 | 2 | 35 | 0 | 0 | 100 | 1,743 |
| 5. Roan × Red-and-White | 117 | 22 | 26 | 25 | 29 | 14 | 16 | 17 | 20 | 51 | 60 | 33 | 39 | 13 | 15 | 25 | 29 | 100 | 117 |
| 6. Roan × Roan | 2,616 | 24 | 628 | 25 | 654 | 8 | 209 | 8 | 209 | 45 | 1,177 | 42 | 1,099 | 23 | 602 | 25 | 654 | 100 | 2,616 |
| 7. Roan × White | 342 | 1 | 3 | 0 | 0 | 6 | 20 | 7.2 | 25 | 47 | 161 | 42.8 | 146 | 46 | 158 | 50 | 171 | 100 | 342 |
| 8. Red-and-White × R. and W | 129 | 31 | 40 | 25 | 32 | 54 | 70 | 50 | 65 | 6[a] | 7 | 0 | 0[a] | 9 | 12 | 25 | 32 | 100 | 129 |
| 9. Red-and-White × White | 321 | 1 | 3 | 0 | 0 | 18 | 58 | 25 | 80 | 48 | 154 | 25 | 80 | 33 | 106 | 50 | 161 | 100 | |
| 10. White × White | 186 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 98 | 182 | 100 | 186 | 100 | 186 |
| Total | 11,685 | 262 | 4,694 | 275 | 5,114 | 167 | 1,385 | 165.2 | 1,204 | 343 | 4,429 | 284.8 | 4,134 | 228 | 1,177 | 275 | 1,233 | 1,000 | 11,685 |

[1] In figuring the percentages given no fractions were considered, e. g., in figuring white by white for red offspring, two individuals recorded as red were found ; this is listed as 1 per cent. In roan by white, three reds were found recorded; this was also listed as 1 per cent out of 342 matings.

[a] All these are entirely within the limit of probable error. The production of roans from red-and-white on red-and-white is caused by individuals of genetic constitution (RrEe) being registered as red-and-white.

| | | | | | |
|---|---|---|---|---|---|
| 3. Red × Roan = | RREE, RREe, RRee × RrEE, rree = | 50 | 8 | 42 | 0 |
| 4. Red × White = | | 0 | 25 | 75 | 0 |
| 5. Roan × R. and W. = | RrEE, RrEe × Rree = | 25 | 17 | 33 | 25 |
| 6. Roan × Roan = | RrEE, RrEe × RrEE, RrEe = | 25 | 8 | 42 | 25 |
| 7. Roan × White = | RrEE, RrEe × rrEE, rrEE, rree = | 0 | 7.2 | 42.9 | 50 |
| 8. R. & W. × R. & W. = | Rree × Rree = | 25 | 50 | 0 | 25 |
| | RrEe × Rree = | 25[a] | 25 | 25 | 25 |
| 9. R. & W. × White = | Rree × rrEE, rrEe, rree = | 0 | 25 | 25 | 50 |
| 10. White × White = | rrEE, rrEr, rree × rrEE, rrEe, rree = | 0 | 0 | 0 | 100 |

[a] Such individuals as *Rosewood Radium* 512686 are probably of the genetic constitution of RrEe, with respect to color, and could be registered as red-and-white.

## HUMAN CUCKOOS AND HEDGE SPARROWS[1]

The cuckoo lays its eggs in the nests of other birds, as we all know; and the little cuckoos aid their unnatural mother in her questionable designs by shouldering out from the nest their still smaller foster brothers and sisters. The cuckoo, moreover, in order to make her own egg less noticeable when she lays it, at the same time robs the nest she is invading of one of its eggs and eats it; thus, if I may so describe it, getting a free meal at the public expense. The point is, however, that these immoral birds increase the amount of care given to each of their young ones by delegating the whole of their responsibilities as parents to several other birds. Now, if natural selection in regulating fecundity is, as it were, only looking to the deaths which occur among adults, we should expect to find nothing unusual in the matter of egg-laying among cuckoos. But if, as I have suggested, fecundity is regulated in accordance with the amount of parental care available for the young, we should expect to find the cuckoo laid more eggs than the nightjar or any other closely related bird with more respectable habits. I confess that I was pleased to find that the cuckoo may lay as many as twenty eggs while the nightjar lays only two.[2] It is even more interesting to note that the number of eggs which the cuckoo

[1] Excerpted from an article by Major Leonard Darwin. "Observations on Fecundity, in the *Eugenics Review* for January, 1923.

[2] The evolutionary results of the cuckoo adopting these methods must have been somewhat as follows. The size of the family at first increased considerably, the size being measured at the time when the young birds became independent of parents or foster parents. This must have resulted in an increase in the cuckoo population. This in turn led to a rise in the death rate, until the size of the family, if measured by the number of offspring who themselves became parents, again fell to two, no more or no less; that is assuming the population to become stationary. See *The Cuckoo's Secret*. E. Chance. Sidgwick & Jackson. 1922.

actually does lay depends on the number of nests which are available, that is, on the amount of delegated parental care on which she can rely. Again, those fish which have no parental cares produce an enormously greater number of progeny than do those fish which look after their young. These facts seem to confirm my theoretical suggestions.

Thus far, we have been dealing with theory and fact, and now I ask you to follow me for a little in the path of imagination. Shakespeare, generally a sound guide both in fact and fancy, tells us that the hedge-sparrow is a bird whose nest is often invaded by the cuckoo.[3] And I cannot but wish that Shakespeare were here to tell us what would happen if the cuckoo and the hedge-sparrow became as good and as wise as human beings. Would cuckoos see the errors of their ways, and at once begin building their own nests? That is asking too much—from cuckoos. Would they perceive that, if they invaded too many nests, there would be an insufficiency of hedge-sparrows for their purposes in the distant future? I doubt it, for a cuckoo will always remain a cuckoo. Then as to a wise and good hedge sparrow, no doubt it would at once perceive that the cuckoo's egg was a changeling for one of its own. But would this virtuous bird think it wrong to eject the ugly intruder? And, if so, would she limit the size of her family so as to be able to give from the first undivided attention to her uninvited foster child? I do not know. I leave it to you to answer these difficult questions. And, in conclusion, I will only express the hope that, when you hear the cuckoos singing in the spring, the following four questions may recur to your minds. In the first place, have we not now many human cuckoos living in our midst; that is, persons of low morals and poor intelligence, endowed with the natural capacity for producing large families, the main object of whose life seems to be to throw the burden of rearing their numerous offspring on to the shoulders of others? Have we not also among us noble-minded but mistaken human hedge-sparrows; that is, persons who, for the sake of easing the strain on well developed but unscrupulous human cuckoos, are ready to sacrifice all their own chances of becoming parents of children of their own kind. Again, in looking to the future of our race, ought we not to consider quality rather than quantity. Lastly, for married couples designed by nature for the task, is not one of their highest duties on earth to take their part in peopling the world with descendants hereditarily endowed with noble qualities?

[3] Shakespeare was in truth a little too hard on the cuckoo.

"The Hedge-Sparrow fed the cuckoo so long
That it had its head bit off by its young."

—*King Lear* 1, 4.

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## Biology and Heredity

GRUNDRISS DER ALLGEMEINEN ZOOLOGIE FUR STUDIERENDE, by DR. ALFRED KUEHN, Professor of Zoology and Comparative Anatomy in the University of Goettingen. Pp. 210. 170 illustrations. $1.10. Leipzig. George Thieme, 1922.

This well-organized introduction to general biology goes into some detail on Mendelian heredity, even to the point of describing linkage and crossing-over. The last section deals briefly with species-building. After pointing out that "pure lines" are artificial products of breeding, the author insists that the species is a "natural genetic unit," because of the free interbreeding of its members in a state of nature. —P. P.

# EVOLUTION OF COMPOUND LEAVES IN WALNUTS AND HICKORIES

## Variations Showing That Lateral Leaflets Correspond to Stipules of Bud-Scales

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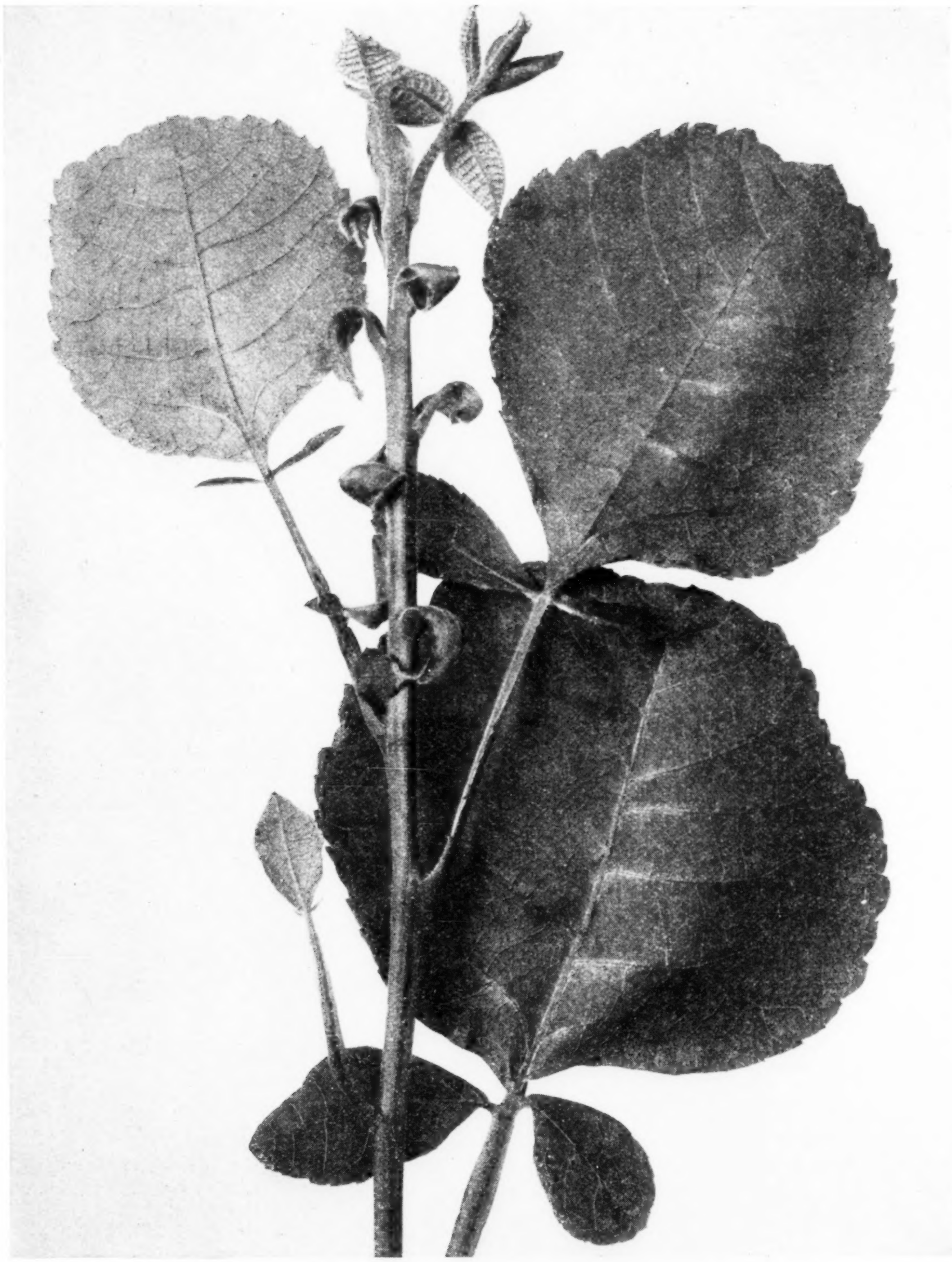
UNUSUAL forms of leaves, intermediate between the bud-scales and the normally developed foliage, occur in several species of Juglans and Hicoria, including *Hicoria pecan*, and may throw light upon the structure and evolution of leaf-forms in this group of plants. Such aberrant leaves have been observed in several localities, and apparently are more frequent on trees growing in rather unfavorable conditions, or where the trees have been injured so that latent buds develop out of season.

Reversion may be defined as the expression of characters that normally are latent, and such characters may contribute to "bud-mutation" or other forms of vegetative variation. Though bud-scales are reckoned as specialized leaves, some of the characters of bud-scales may be primitive, as representing earlier stages of foliar evolution, of the period when the ancestral plants adapted themselves to seasonal changes that made bud-scales necessary.

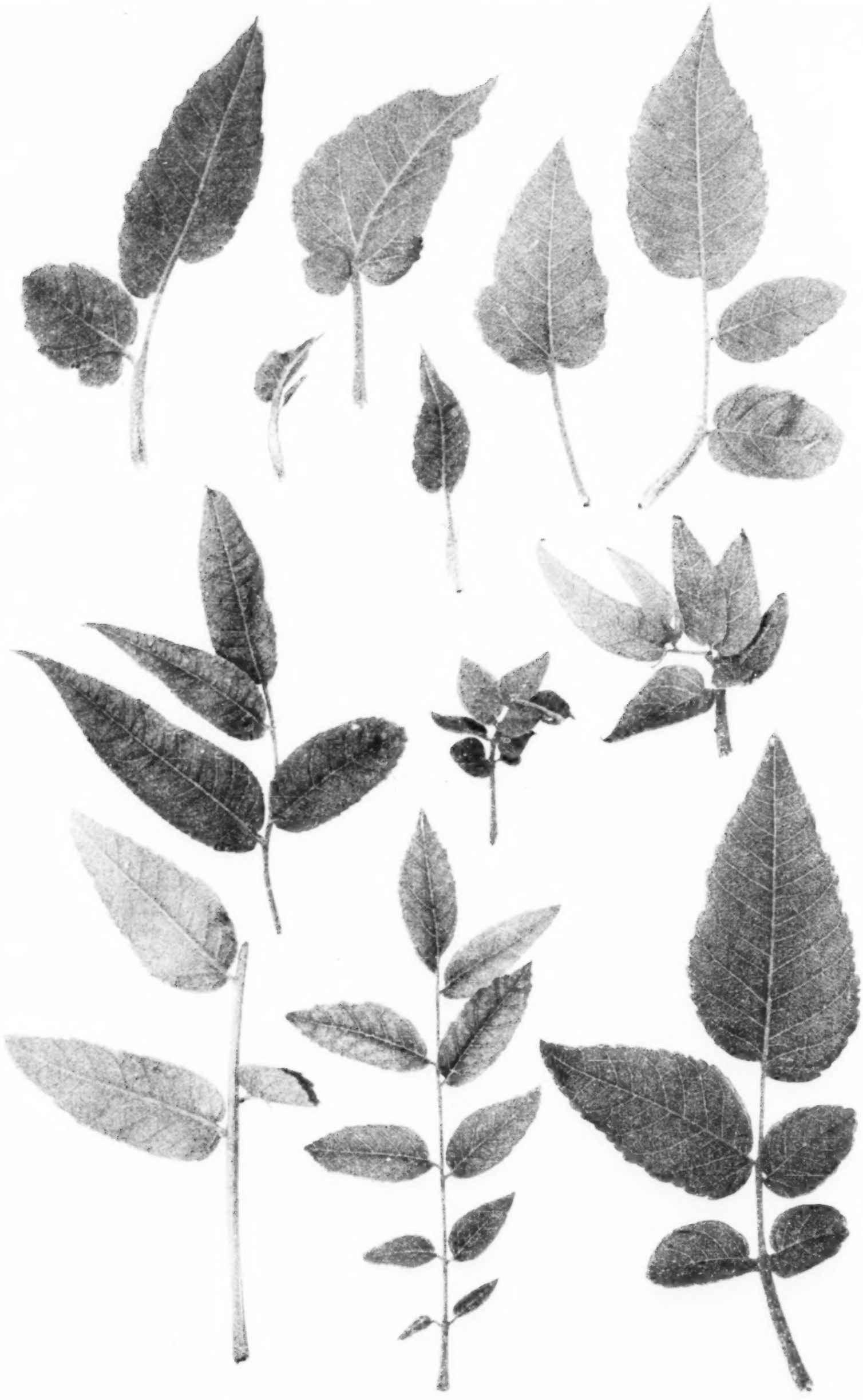
The study of leaf-forms should not be restricted by the idea that leaves are mere appendages of the stem or axial system, as formerly assumed by many writers on plant anatomy. The axis of the higher plants is not a simple structure but an aggregation of vegetative internodes, each internode representing a part of a metamer or structural unit of a compound organism. Some of the metamers are not represented by vegetative internodes, as bud-scales, bracts, petals, stamens and pistils. The plant body as a whole is a colony of diversified metamers, so that each joint or internode with its leaf or leaf-equivalent is a distinct morphological unit. The development of the plant is shown by a succession of internode individuals of different forms, produced one from another. The jointed, internodal structure of the plant, and the evolutionary significance of different forms of leaves on successive internodes, were recognized clearly by Goethe in his poem on the evolution of plants, published in 1790.

The modern evolutionary study of homology began with Goethe, who connected the two ideas of structural correspondence and community of descent. "The same organ," as Goethe said, "which on the stalk has expanded as leaf and taken a manifold diversity of form, now contracts itself in the calyx, expands again in the petal, and contracts in the sex-members, to expand finally as fruit." The need of a general word was noted, "wherewith we could designate this so variously metamorphosed organ, and compare all of the manifestations of its form." Although Goethe's view of the structural relations was condemned by some botanists of the last century as a "wildly absurd theory," it now is generally accepted, and such terms as internode, metamer and phytomer are in use as names for the "metamorphosed organ." In the writings of Goethe the diversities of the internode



METAPHANIC VARIATIONS OF HICKORY LEAVES

FIGURE 9. Late shoot of hickory, developed in partial shade at Lanham, Maryland, in August, 1922, with expanded bud-scales functioning as leaves. A series of eight internodes producing intermediate forms of leaves, followed by eight shorter internodes with somewhat enlarged bud-scales, at the end a young leaf of the normal compound form, with only the lowest pinnae expanded. The last bud-scale, standing nearly erect, is somewhat more leaf-like than the others, showing a larger blade rudiment and having the lateral wings of the base produced above into diverging stipule-like organs, which also appear in more rudimentary form on the smaller or more normal bud-scales. The leaves have winged bases like the bud-scales, and some of the wings are produced above into small, delicate, transparent, stipule-like appendages, closely similar to those of the bud-scales, while other leaves show larger stages of development of the stipular appendages, including broad pinnae not unlike those of the normal compound leaves. (Natural size).



PRIMITIVE LEAF-FORMS OF WALNUT

FIGURE 10. Leaves from small late shoots of "Royal" walnut at Bard, California, September, 1922, showing a range of forms, from simple to compound. Some of the smaller leaves have the base distinctly winged and with distinct stipules, or with a stipule on one side opposite a broad pinna. At the upper right-hand corner is a leaf with two stipules on one side, with broad pinnae opposite, showing that stipules are reduplicated and are morphologic equivalents of pinnae. (Natural size).

members served at once as an illustration and a proof of the development of divergent forms from the same ancestral type. The same idea of metamerism was applied even to the higher animals, in comparing the skull bones with the vertebrae.

Though the first thought in homology is of structural correspondence, evolution is the fundamental idea. A difficult or doubtful homology involves the idea of divergent paths of evolution, so far separated that the present diversity has obscured the original identity. But by tracing the evolutionary paths something may be learned of the original structure and of the intermediate stages of development. For progress in the study of heredity as well as in breeding and selection, it is desirable to know the evolutionary status of the characters, so that reversions and pathological abnormalities may be distinguished from normal diversities or progressive changes of characters.

The most primitive forms of leaves may have resembled the cylindrical sheaths of Equisetum, or may have arisen as expanded, sterilized stamens, which is the usual interpretation of the petals and sepals. Different origins may be indicated by the completely different types of leaves that occur on some plants, as the junipers and eucalypts. It is of interest to trace corresponding developments of leaf-structure in the several families of plants to see how far such structural correspondences, or homologies, can be established.

### Two Primitive Leaf-Elements

Instead of the customary division of the leaves of higher plants into three structural elements, stipules, petiole and blade, two primary elements may be recognized, the foot and the blade. The foot represents a primitive sheathing leaf-base that encircled the next internode, while the blade is the expanded portion of the leaf, so variously developed in the different families of plants. Stipules and petioles, in this view, are secondary specializations. Stipules may be considered as segments or subdivisions of the primitive foot element, while petioles apparently are of two or more kinds, of different derivation and hence not strictly homologous. Some petioles represent a narrowed basal portion of the blade element, while others have developed by narrowing the terminal portion of the foot element. A distinct joint or pulvinus at the end of a petiole may indicate the primitive articulation of the blade element with the foot element.[1]

### Stipules on Bud-Scales

Although stipules are supposed to be absent in the Juglandaceae, stipular elements may be recognized in the bud-scales, in rudimentary organs that correspond directly to the lower pinnae of the compound leaf. Reasons are found also for viewing the other lateral pinnae as reduplications of the lowest, stipular pair, so that only the terminal unpaired leaflet is left to represent the original blade element, corresponding to the simple leaves of seedlings and to simple leaves of other plants. If these homologies are correctly inferred, the evolution of compound leaves may be traced in this family, not through expansion and division of simple leaves, but through development and reduplication of the stipular elements. This interpretation need not be refused because in other families the stipules may have been suppressed or retained as merely rudimentary organs. (See Figures 9 to 14, with explanations describing several variations.)

[1] General Morphology of Leaves. *Journal Washington Academy of Sciences.* Some leaves may consist of an expanded foot, with the blade element entirely suppressed, or possibly never developed. See ARBER, Leaf-base Phyllodes among the Liliaceae, *Bot. Gaz.* 69: 337. 1920.

### Homologies of Stipules and Pinnae

If the walnuts and hickories had only one pair of lateral pinnae the relation of these to stipules might be more apparent. It would hardly be questioned that the base of the compound leaf, below the first pinnae, corresponds to the primitive foot, or sheath element, while the stalk of the terminal leaflet corresponds to the petiole of the simple leaves of hickory seedlings, or to the petioles of some of the plants that have simple leaves, as the peach, plum and apple. The correspondence is complete in the walnut and hickory bud-scales, where the leaf-base, or foot, takes a broad sheathing form, and is still obvious when lateral wings are shown in the intermediate forms of leaves, between the bud-scales and the fully developed compound leaves. Only in the large, adult forms of leaves, with the full number of pinnae, are there no traces of stipular wings on the leaf-base. Lubbock has noted the protection of the bud of the walnut by the "dilated base of the leaf-stalk" as a special feature, but the winged bases and stipules of the bud-scales and small leaves apparently were not observed. (See Figures 9, 10, and 14.)

The lowest pinnae of the intermediate forms of leaves also show special relations with the lateral wings of the petiole. In many cases, especially in the pecan, the wings of the leaf-base are wider above and run out upon the midribs of the pinnae. Moreover, many of the pinnae that have winged midribs are cut away at the base on one side, forming a characteristic broad notch, sometimes strikingly developed. The basal portion of such pinnae, where the lower side is cut away, may also show a strong curvature, or the entire lower pinnae may be curved downward, so that they appear quite different from the others. (See Figure 12.)

### Pinnae Replaced By Stipules

Pinnae of the intermediate leaf-forms occasionally are replaced by small, transparent, narrowly-pointed organs, closely similar to those that terminate the lateral wings of the expanded bud-scales. No doubt these small organs would have been recognized as stipules if they occurred regularly in the normal leaves, instead of being developed into pinnae, and the wings suppressed. All degrees and stages of development are found between thin, narrowly-tapering, thoroughly stipule-like structures and fully developed lower pinnae, of the same size and shape as the others. The extent of foliar development of the basal organs seems especially variable. As shown in Figure 9, some of the stipule-like pinnae are very slender and delicate, and these may consist entirely of pale, semi-transparent tissue, or the lower side may be of thin, stipular texture like the wing of the leaf-base, while the upper side, above the midrib, has a narrow or broad band of green tissue, like that of the normal pinnae. Replacement of pinnae by rudimentary organs is not confined to the lowest pair as shown in Figure 9, or even to the second pair, as shown in Figure 14, but may occur with any of the lateral pinnae as shown in Figures 10 and 11.

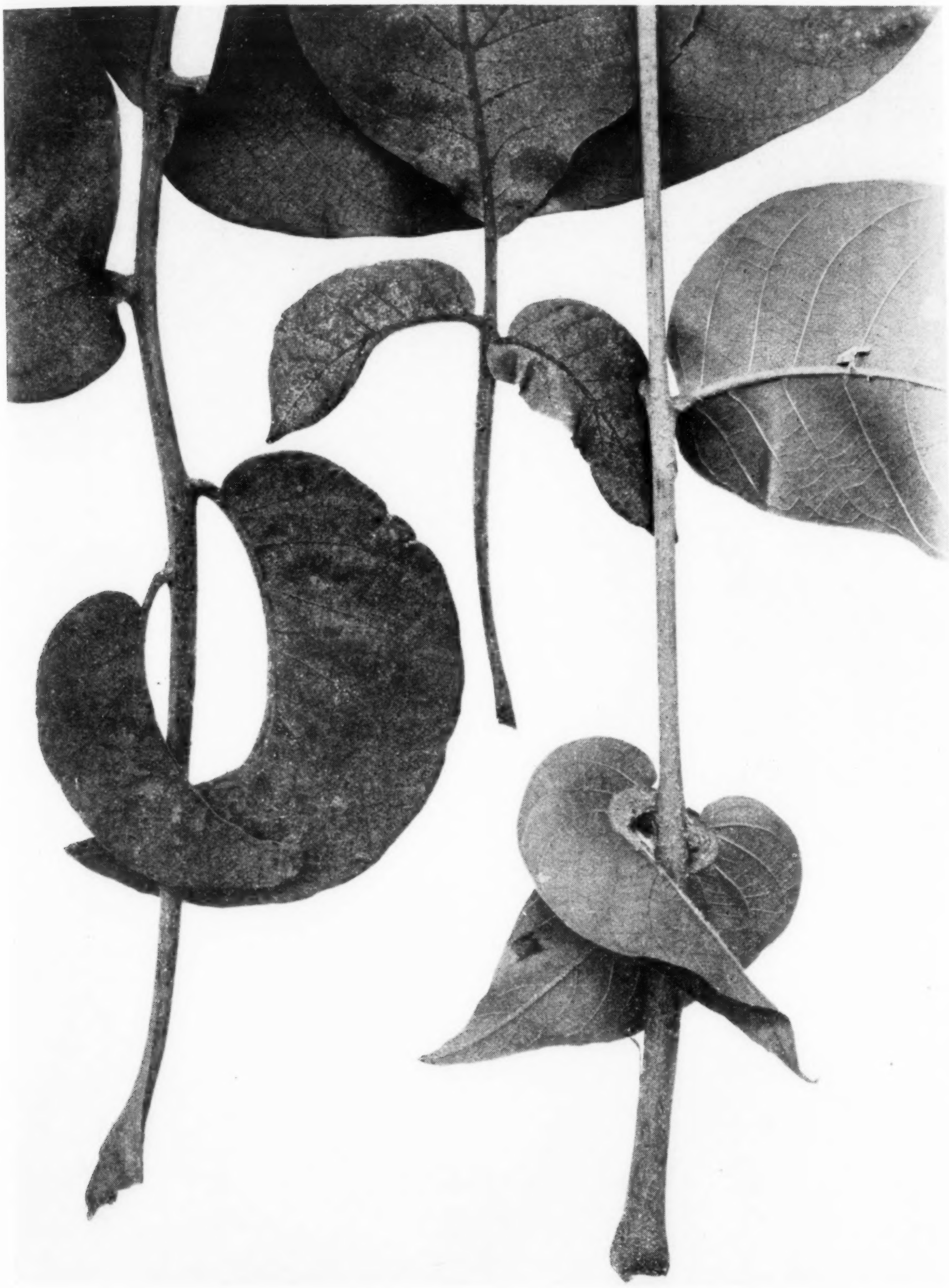
### Development of Compound Leaves

With the lower pinnae thus appearing as homologous with stipules, a like origin and development from the primitive stipular element is indicated for the other pinnae, especially in cases of replacement of pinnae by small stipule-like organs and by more frequent occurrence of basal emarginations on other lateral pinnae, or on all of the lateral pinnae, as happens not infrequently in the pecan. Though no indications of lateral wings have been observed on the joints of the rachis, between the successive pairs of lateral pinnae, this is not to be taken as a reason for supposing that the upper pinnae are different from the lower, in view of the complete suppression of wings from the bases of the adult form of leaves.

Supposing that the other pinnae are of the same nature as the lowest pinnae,

**WALNUT LEAF WITH PINNAE REPLACED BY STIPULES**

FIGURE 11. A late-growth leaf of "Royal" walnut, at Bard, California, September, 1922, with an upper pair of pinnae replaced by small stipule-like organs. Other leaves of the same tree showed other pairs or single pinnae replaced in the same way, including cases of the uppermost lateral pinnae so replaced, which seems to prove that the small stipule-like organs are structural equivalents of the pinnae, and indicates the possible derivation of the pinnae through reduplication of stipules. (Natural size).



LOWER PINNAE OF PERSIAN WALNUT LEAVES

FIGURE 12. Intermediate leaf-forms of the Persian walnut at Chico, California, with the lateral pinnae reduced in number and of different forms. The small leaf in the middle has only one pair of lateral pinnae, and these unequal. The left-hand pinna of this leaf is cut away on the lower side for half its length, while the right-hand pinna has the leaf-web complete and of nearly equal width on both sides of the midvein. The lower pinnae of the left-hand leaf are strongly curved and completely one-sided, with no leaf-web at all on the lower, or proximal, side of the midvein. The right-hand leaf shows an even stronger curature of the basal pinnae, but only at the base where the wings of the leaf-base run out upon the pinna. (Natural size).

the compound leaf of the walnut family appears to have been developed, not by subdivision of the original simple leaf but by reduplication of the foot element, with its stipular elements, to form the several joints of the rachis and the corresponding pairs of pinnae. The number of pinnae is quite variable in this family, among the leaves of the same trees, with extreme reductions to one or two pairs of pinnae in the bud-scales and small adjacent leaves. Reduplication of stipules occurs in other families, including the Malvaceae. Some varieties of okra have four or more stipules, and the involucres in cotton and related genera may have been developed through reduplication of stipules. Although the usual forms of compound leaves do not appear in the Malvaceae, a complex structure may be indicated by the radial lobing.

In the walnuts and hickories, at least, we are brought to consider that the major part of the leaf, up to the insertion of the terminal pinnae may be derived from the primitive foot element, with only the terminal pinna and its petiole representing the blade element of a simple-leaved plant. Considering that the blade of the primitive leaf may have arisen as a specialized median appendage or lobe of the foot, the stipules may be reckoned as lateral lobes of the same foot element. Thus the foot would appear as a single primary element with one median and two lateral lobes, developed as blade and stipules. In some families only the blade has developed foliar, assimilative functions, in others the stipules also. In the walnut family the stipules as well as the median blade element have had a foliar development, no doubt at first merely supplementing the blade element, but eventually over-balancing and replacing the blade.

### Nature of the Intermediate Leaf-Forms

A general tendency in the later evolution of the compound leaves is to equalize the terminal and lateral pinnae. The terminal pinna, instead of being much larger and broader than the lateral pinnae, as in the primitive and intermediate leaf-forms, is reduced to nearly the same size as the lateral pinnae. Indeed, the reduction of the terminal pinna often is carried to the stage of complete suppression, as occurs in some of the pecan varieties, and in some species of walnuts, including *Juglans californica,* the parent of the remarkable "oak" walnut mutation. In this the terminal pinna is regularly developed and the lateral pinnae reduced to two pairs, or replaced by small stipular organs like those of the bud-scales. (See Figures 13 and 14.)

When the terminal pinnae are reduced to the same size as the others, their only distinctive features are bilateral symmetry and the possession of a petiole, but occasionally the lateral pinnae also are stalked, as observed at Sacaton, Arizona, in many leaves of the Frotscher pecan. This may be considered as a further step toward equalizing the pinnae, with the lateral pinnae beginning to show a character that previously was confined to the terminal pinna. Likewise, the development of the rachis by intercalation of more numerous joints and additional pairs of pinnae may be considered as a reflection or imitation in the leaf of the jointed structure of the stem.

The evolutionary interest of such equalizing tendencies among the different parts of plants was first recognized by Leavitt, who considered such characters as having been transferred from one part of a plant to another, by a process which he called homoeosis. But if it be supposed that the characters exist potentially in all the parts of a plant, the idea of a transfer seems unnecessary, since the apparent transfers may result from changes in the expression of the characters. Such changes would account not only for different degrees of expression but also different combinations with other characters. In the words of East: "One must realize that each gene has many

effects on the organism, some of which are not easily discoverable." This is another way of saying that the problem of expression of characters should be separated from the problem of transmission. The "effects" may be changed by altering the expression-relations of the characters. To designate such variations, that show intermediate stages and combinations of characters, the word metaphanic has been suggested.[2]

## Evolution Through Mataphanic Variations

Special evolutionary interest may be claimed for metaphanic variations, since the development of new somatic features may go forward through such changes in the expression of characters, without the need of supposing that definitely new characters have been formed in the "mechanism of heredity," which serves for the transmission of characters. Since many evolutionary changes could be explained by supposing that characters already existing have been readjusted or recombined in their expression, fewer fundamental changes in heredity would be called for, if metaphanic changes were recognized. No doubt many metaphanic variations are abnormal or degenerative, as when a loss of specialization results from parts becoming more alike, but some of the variations may be progressive.

An example of evolution that may be ascribed to metaphanic changes is the development of the jointed rachis of the compound leaves, which may be viewed as an intermediate expression or partial reflection in the leaf of the jointed, internodal structure of the stem. In the course of their development, the compound leaves of the walnut family have become more stem-like or branch-like, contrasting in this respect with other families where the tendency is for branches to become more leaf-like. In such cases as Phyllanthus, Zizyphus and Castilla the branches have not only the general form of compound leaves but also the temporary and deciduous behavior of leaves, through the development of a specialized joint or abscission layer at the base.

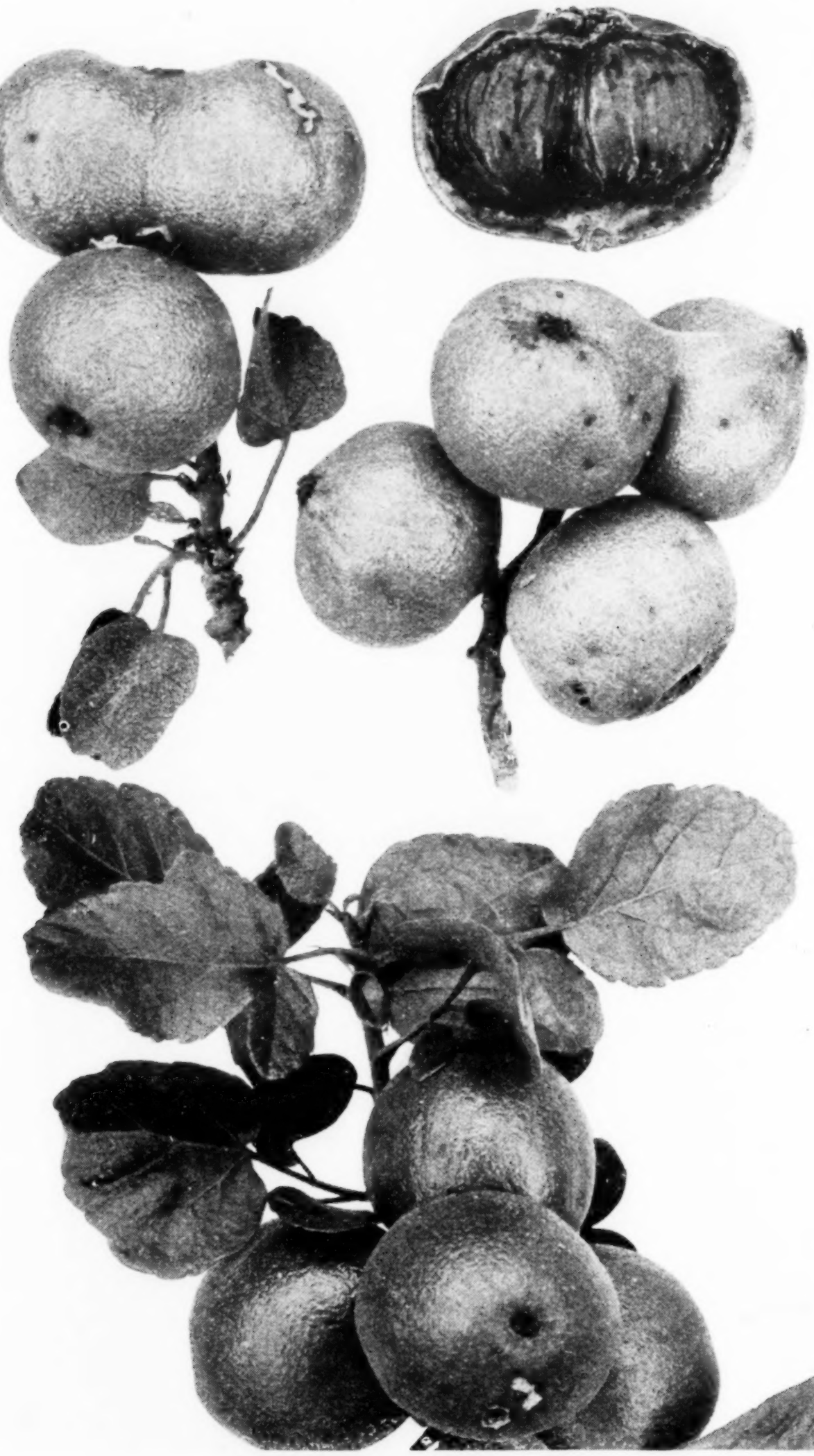
Cotton, coffee, cacao and many other plants are like Zizyphus in having two or more distinct forms of branches. Intermediate forms of branches may occur in abnormal cotton plants, and such branches may be completely sterile like hybrids of diverse species. In less abnormal cases flower-buds may be formed at each point of the intermediate branches, but all the buds are aborted and shed before the fruiting stage is reached, as in the so-called "bull-stalks" of Sea Island cotton. Sterility, however, depends to some extent on the external conditions, since a few bolls may be set late in the season on plants that have aborted all of the earlier buds.[3]

Metaphanic variations show that the problems of adaptation are not merely external, in relation to the environment, since there also are problems of internal adjustment, or relations of the parts to each other. With the principle of metaphany recognized, a wider view is possible of the relations of the characters or parts of an organism to each other, since parts or characters of independent origin may be combined or rearranged through metaphany. The metaphanic variations show a general lability and interplay of the characters in their expression relations, which are significant alike for heredity and evolution.

Metaphany may be defined briefly as internal hybridism, resulting in the formation of intermediate structures, so that specialization is reduced in the sense that metaphanic variations render

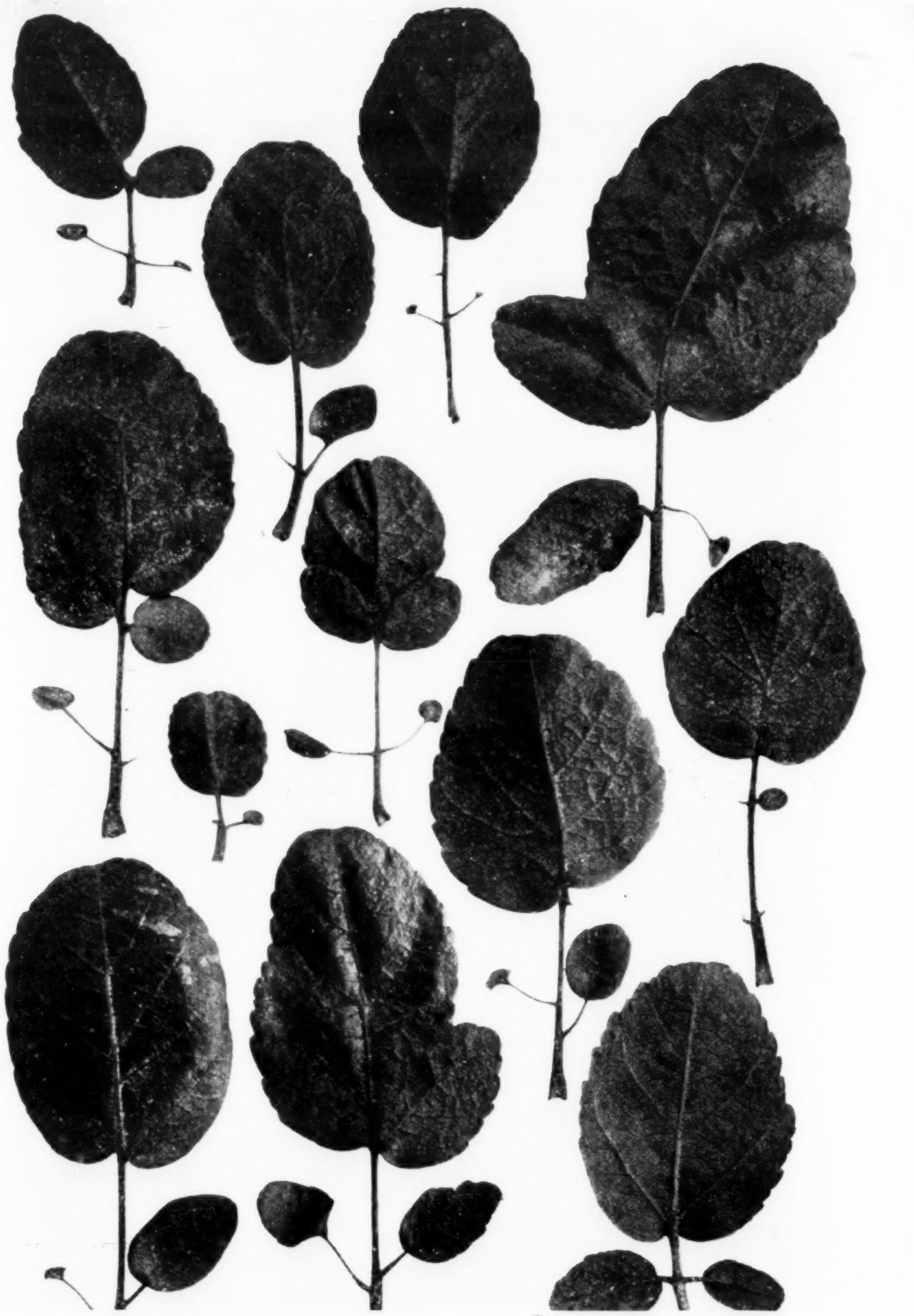
[2] Brachysm, A Hereditary Deformity of Cotton and Other Plants, *Journal of Agricultural Research*, III. 387. February 15, 1915.

[3] See, Causes of Shedding in Cotton, *Journal of Heredity*, 12:119. May, 1921. Also, Dimorphic Branches of Tropical Crop Plants, *Bul.* 198, Bureau of Plant Industry, U. S. Department of Agriculture, 1911.



**THE OAK-WALNUT MUTATION**

FIGURE 13. The oak walnut is a peculiar mutation of the native California walnut (*Juglans Californica*), so distinct from the parent type as to have been described as a distinct species, *Juglans quercina*. When first discovered it was supposed to be a walnut-oak hybrid, on account of the peculiar shape and the thick leathery texture of the leaves. (See BABCOCK, E. B., A New Walnut, *Journal of Heredity*, Vol. VI, p. 40). Some of the leaves are simple with only one pair of lateral pinnae, but most of the leaves have two pairs of pinnae. The small size of the leaves and the reduced number of pinnae may be explained by analogy with the intermediate or bud-scale leaves of other members of the family, but complete suppression of the normal compound leaves is remarkable. A variety of the Persian walnut has also been described under the name *Juglans monophylla* to which the California oak-walnut may be analogous. A tree of the oak-walnut at the U. S. Plant Introduction Garden at Chico, California, bore a large crop of ripe fruits in September, 1922. Many of the fruits were twinned, mostly with separate nuts, but in some the shells of the two nuts were grown firmly together, as shown at the top of the photograph. (Natural size).



LEAF FORMS OF THE OAK WALNUT

FIGURE 14. Showing replacement of pinnae by small stipule-like organs, which occurs frequently in leaves of the oak walnut. In some cases both pairs of pinnae are replaced, either by simple stipules, or by slender, stipule-like organs that serve as pedicels for very small pinnae which are quite variable in form, oval, circular, or cup-like. The cup-like pinnae, or "ascidia," apparently are formed by union of the basal margins below the point of attachment of the leafy portion of the pinna with the stalk. Formation of these cup-like pinnae may indicate a backward growth of the leaf-web, from the apex toward the base along the midvein. Note that in several of these leaves one or both of the lateral pinnae have united more or less completely with the terminal pinna as in the lower right-hand leaf. Also compare this leaf with Figure 9 to observe the close approximation with the bud-scale leaves of hickory.

the affected parts less different than they previously were, though such changes may give increased utility to particular organs, and thus increase the efficiency of the organism. With such variations occurring rather frequently, it may be considered that the adaptive possibilities of the different combinations of characters are being tested automatically in relation to the environment, and that under natural conditions the species has the benefit of any desirable modifications that arise. The liability to metaphanic variations enables the species to conduct, as it were, a continual trying-out of adaptive possibilities, not only of all of the existing characters, but of all of the stages and degrees of character-combinations.

For purposes of evolutionary study, two kinds of metaphanic characters or expression relations may be recognized, those that may be considered as more primitive, or in the nature or reversions to earlier stages of development when structures were less specialized, and those that may be considered as recent stages or of possible significance in future evolution, if successful combinations are made of characters not previously associated. While the intermediate or bud-scale leaves of the walnuts and hickories must be considered as reversions to more primitive forms, an advance appears to have been made in building up the compound leaves, by a jointed structure like the stems developing in the leaves and branches. It is desirable to have a general name for the intermediate variations while the evolutionary status of such characters is being determined.

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## Meeting of the Eugenics Research Association

The program committee of the Eugenics Research Association has set Saturday, June 16 as the date for the annual meeting this year. As usual, it will be held at the Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y.

Judge Harry Olson, of Chicago, will deliver the presidential address on "Crime and Heredity."

It is announced that "the 1923 meeting will have to decide several important matters of policy, such as that of incorporation, of planning definite scientific investigations, and the cooperative division of the field logically covered by eugenics societies, with particular reference to research, on the one hand, and education on the other."

The executive committee announces that on February 10 it "voted a small stipend to Dr. Harrison R. Hunt to aid in his studies on 'War and Eugenics.' This marks the first official appropriation for specific research made directly from the treasury of the society."

# TWIN AND TRIPLET PEACHES

C. H. CONNORS

*New Jersey Agricultural Experiment Station, New Brunswick, N. J.*

THE OCCURRENCE of double fruits on peach trees is not uncommon in any season, but certain seasons seem to bring forth larger numbers. Blake and Connors[1] reported the large numbers found in the experimental orchards at Vineland, N. J., in the season of 1915. These were not in such large proportion as those reported by Karper.[2]

Multiple fruits may occur by two methods, and by combination of these two methods. The peach more frequently than not sets three buds at a node, two blossom buds with a leaf bud between. In some cases, three and four flower buds are formed at a node. Frequently, twin flowers are formed, originating from a single bud and upon the same pedicle (Fig. 15). The two conditions are not easily confused. The stigmas of the twin flowers usually become receptive simultaneously, and may be pollinated at the same time. Given normal conditions following pollination, the ova will be fertilized and the fruits will develop at approximately the same rate, resulting in more or less symmetrical twin fruits.

The second method is by multiple pistils. As is well known, peach blossoms have normally only one pistil, but Figure 16 depicts blossoms having one, two, and three pistils, and Figure 15 shows immature fruits developed from such blossoms. The writer has never seen more than three pistils in the blossoms of the edible peaches, but the ornamental double-flowered forms have from one to six pistils. In the course of emasculating and pollinating more than 10,000 peach blossoms during the spring of 1922, opportunity was given to study the development of multiple pistils. All gradations were found. The first step appeared to be fasciation of the stigma, then a fasciated style; the next gradation appeared to be two stigmas on a fasciated style, then two stigmas and styles upon a fasciated ovulary and finally, two distinct pistils. Very frequently, however, one pistil is less developed than the other, and probably is never pollinated, resulting in either a single fruit or else the pericarp develops very slowly, resulting in some of the odd forms.

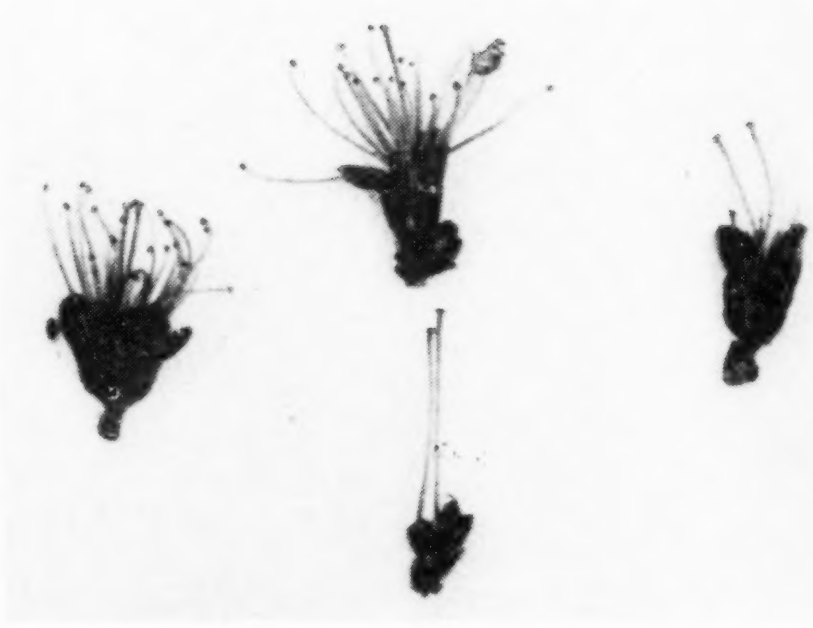
By combining these two forms, a twin flower, one of the members of which is double pistillate, might give a triple fruit as well as a single flower with three pistils; twin flowers with both members double pistillate might give quadruple fruits; and so on.

In the first figure of the paper by Karper, what appears to be a quadruple fruit, judging by the illustration, is really not a quadruple fruit on a single pedicle, but seems to have been formed from the usual three bud formation, in which the blossom buds each developed into twin blossoms, resulting in double fruits, while the leaf-bud failed to develop, allowing the two double peaches to come into intimate contact in such a way that a quadruple fruit seemed to be formed.

The range in development attained in double fruits is shown in Figure 17 in which six specimens are shown whole and in section. It will be noted that in the case of one fruit, at least, the growth appears to be purely vegetative. Possibly the ovum was not

[1] BLAKE, M. A., and CONNORS, C. H. Odd Forms of Peaches. *N. J. Stas. Rept.* 1916, p. 78.

[2] KARPER, R. E. Compound Fruits of the Peach Resulting from Multiple Pistils. *Journal of Heredity*, xii:402-406. 1921.



SINGLE, DOUBLE, AND TRIPLE PISTILS

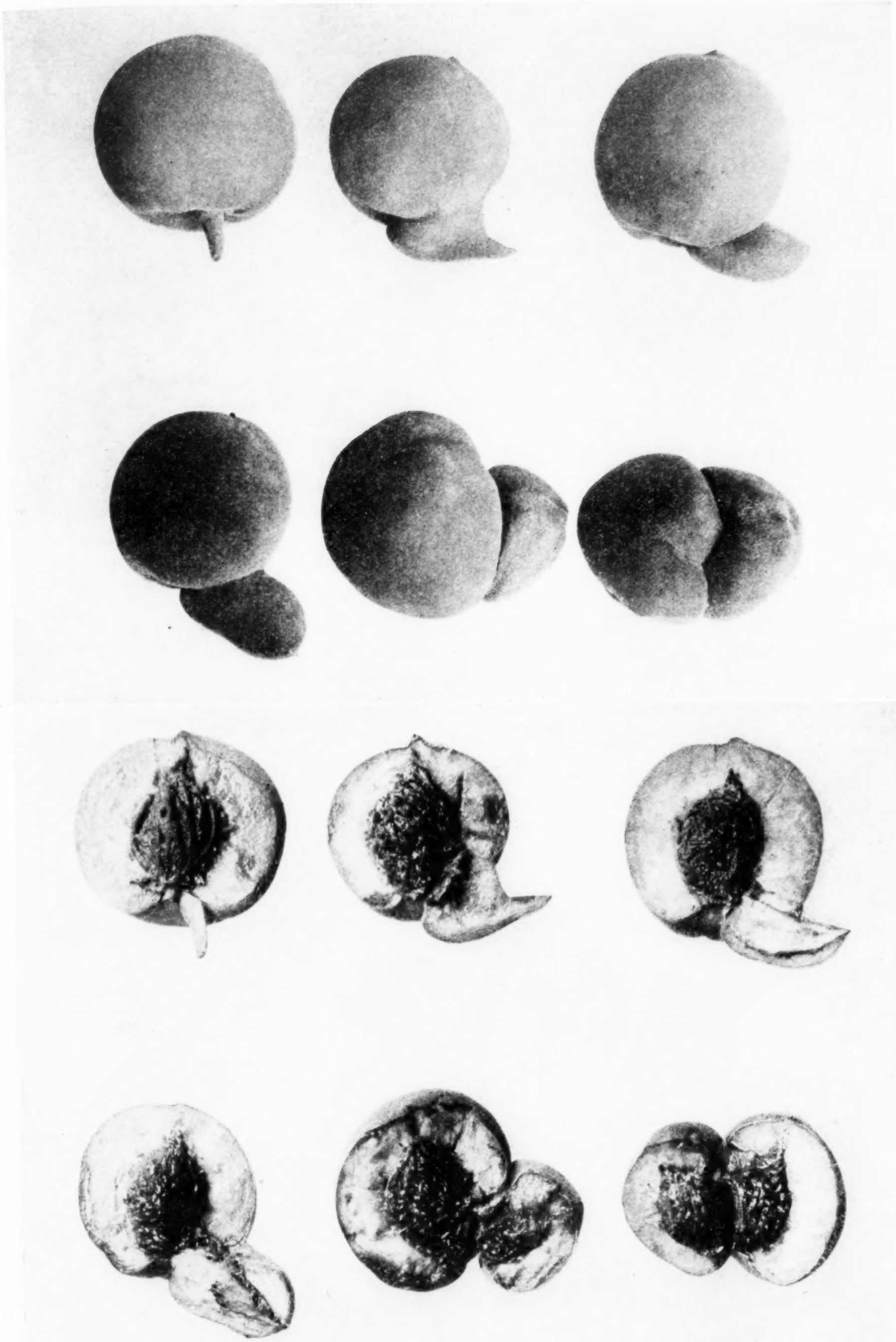
FIGURE 16 The twins and triplets formed from such pistils are usually markedly different in size, as shown in Figure 17. The triple-pistilled flowers are shown at the right and left of the picture. One pistil is considerably shorter.

TWINS AND TRIPLETS

FIGURE 15. Twin peaches are formed in two ways, (1) from twin flowers (center row), and (2) from a single flower having twin pistils. Triplets are produced either by a combination of these two methods—by twin flowers one of which has double pistils (d and e), or by a single flower with three pistils (b and c, top row). Flowers with more than three pistils are very rare, and quadruplets are in reality double twins, twin double-pistilled flowers producing the quadruple form (a, top row). On the bottom row is shown how twinning occurs by the formation of a double flower. Normally three buds are formed at each node, a leaf bud and two flower buds, which produce two separate fruits, as at (a). Sometimes a double flower is formed in place of one of the single ones. Twin peaches from such double flowers are usually of about the same size, while those from double pistils are unequal in development.

fertilized, but the fruit was able to develop slightly because of its close connection with the larger fruit.

There is considerable variation among varieties in the setting of these multiple fruits. Of the list given by Karper, Mayflower, Alton, Japan Dwarf Blood, and Hiley belong to the Chinese Cling



TWIN FRUITS ENTIRE AND IN SECTION

FIGURE 17. Fruits from a twin flower are shown in the lower right-hand corner. The five other twins were produced by flowers with double pistils and development has been very unequal. In one case, at least, growth of the second fruit appears to have been purely vegetative.

group; and in our observations of 150 to 200 varieties, the varieties of this group rarely form multiple fruits. The remainder are of the so-called Persian or Crawford group or are inter-group hybrids. In normal years, more double fruits are seen on varieties such as Foster, St. John and other closely related varieties of the Persian or Crawford group, and our observations show that the majority of these are probably formed from twin flowers rather than from single flowers with double pistils.

The causes of this phenomenon may be many. The tendency seems to be hereditary among a certain group of varieties. The occurrence would seem to be due to environmental conditions and any environmental factor or combination of factors which would tend to bring about doubleness would cause this multiplication.

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## When To Marry

The age at which one should marry presents a problem with so many sides that any simple solution of it is out of the question. But it is a question on which every one holds a definite opinion; so the *Umschau,* a German weekly devoted to popular science, is likely to find many contestants for prizes aggregating 40,000 marks, which it offers for the best brief essay on the subject. It desires that the question be considered from the points of view of genetics, hygiene, psychology and psychiatry, either collectively or singly. Judges of the contributions are Max von Gruber, Professor of Hygiene in the University of Munich, and one of the leaders of the eugenics movement in Germany; Valentin Haecker, a well-known geneticist at the University of Halle; and H. Bechhold, of Frankfort am Maine, editor of the *Umschau.*

From France, at the same time, comes a partial attempt to answer the question, in a paper by Dr. Paul Godin, which occupies the leading position in the second number for 1922 of *Eugénique,* the organ of the French Eugenics Society. Dr. Godin's study, entitled "Eugénique et Puberté," leads to the conclusion that on the average, a woman is physiologically ready for marriage at eighteen and a half years, a man two years later. The data on which these conclusions are based are far from conclusive, however.

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## Lives of Fossil Animals

LEBENSBILDER AUS DER TIERWELT DER VORZEIT, by OTHENIO ABEL, Professor of Paleontology at the University of Vienna. Colored frontispiece and 507 text figures. Pp. 639. Jena, Verlag von Gustav Fisher, 1922.

Paleontology has played an important part in forming the general doctrine of evolution, and paleontologists have not hesitated to draw precise conclusions involving somewhat detailed points of genetics—conclusions which most geneticists have been inclined to challenge, on the ground that the fragmentary documents afforded by fossils are not detailed enough to warrant precise conclusions. Nevertheless, every contribution from the realm of prehistoric animals is welcome to the student of heredity, and the lavishly illustrated volume by Dr. Abel is particularly attractive. The author's plan is to give a detailed description of the life of ten different periods, regarding which the extant evidence is fairly abundant. Three of the regions considered are in the United States. —R. P.

# A REVIEW OF REVIEWS

## Of Madison Grant's

## PASSING OF THE GREAT RACE

IT IS now six years since the first edition of Madison Grant's "Passing of the Great Race" attracted the attention of the reading public to discussions centering about heredity, and caused even at its inception, as scientific books go, considerable of a sensation. It was violently attacked. It was heartily commended.

Much of this controversy was evidently emotional in its origin, and now that the Great European War is a thing of the past it is easy to see that many of the hostile reviews were actuated by a feeling that Madison Grant was echoing the dangerous Germanic theories of Gobineau, Nietzsche, and Houston Stewart Chamberlain and was, perhaps, hooting a little at the then popular slogan: *Make the World Safe for Democracy.* Some of the reviews were evidently personal resentments from individuals not belonging to the so-called Great Race. Another class of criticisms came from scientific men who deplored the absence of all foot-notes and specific references, and felt that this book, even though it might be essentially true, had been written in a partisan spirit, and that many of the detailed assertions could not be substantiated by research data.

The present writer reviewed the second edition in something of the latter spirit, on the whole favorably, in *Science*, October 25th, 1918. Now that a new edition has appeared giving very complete references to authorities, it is only fair to give the book another review. It seems the references were left out intentionally in order, as the author told the present reviewer, "to get people to read the book." "You scientific men are too modest. You lumber up your books with references to authorities. The reading public cares nothing for the scientific names; their eyes and minds are confused by the foot notes. They want to read directly from their author."

This seems to the reviewer to be worth putting down in print in this, a scientific journal, since all scientists have to consider the art of presentation, and naturally wish their researches to be known, at least to someone besides themselves. Scientists enjoy foot notes, the names mean everything to them; but ultimately scientific knowledge has to be presented to the general public, and it is through just such readable and popular books as Mr. Grant's that this matter is accomplished.

The latest edition,[1] seventh printing, fourth edition, revised 1921, contains 263 pages of text and 176 pages of documentary supplement, all the references to authorities being placed in the appendix. Mr. Grant does not intend to lose any readers by stopping them in the text.

By taking the references one by one and turning to the indicated page and line the names of the authorities can be filled in. The present reviewer has done this for most of the book, writing the names in pencil on the margin. It appears that the major portion of the text is supported on good structure of researches and authoritative opinions.

There are nevertheless a good many assertions that appear exaggerated, and are at least statements that cannot at the present day be referred to any exact investigations, simply because mankind has been so tardy in recognizing the importance of the "proper study of mankind," and has not much

[1]Published by the Charles Scribners Sons, New York. Price $2.50 net.

utilized in any objective spirit the immensely valuable record we commonly call "history." One point at least can be certainly made, that not one of the hostile reviewers has taken any point to point method of evaluation. They do not appear to be actuated by a desire for truth. For instance, such general assertions as the following are frequently found among the reviews for the most part written during the late European War: "All that can be said of some of the statements brought forward by Mr. Grant as scientific evidence of his thesis is that they are incorrect."—*London Times,* May 3rd, 1917.

The phraseology is "some of the statements," but unless the sentence is read very carefully it gives the impression that most of the statements are incorrect. This is the only sentence quoted by the *Book Review Digest* in its general summary of all important reviews for February, 1918. The mark minus (—) is placed against it. This is a good illustration of the sort of injustice that may be done a book when editors are war-mad. The *London Times* then attacked two comparatively unimportant and probably erroneous assertions of Mr. Grant. First, that the Nordics were killing themselves off in the Great War, and second, that human characters obey Mendelian laws during their hereditary descent.

The *Dial,* May 17th, 1917, said: "The science is so pure that it is altogether imperceptible." "This form of arrogance is not new in the history of civilization."

"Anti-Democracy" is the heading of the review in the *Athenaeum,* July, 1917. "It is an axiom with Mr. Grant —for he makes not the least attempt to prove it—that heredity is more than environment." (The present edition gives the references.) "We had thought that this species of race ecstacy, this enthusiasm for laying stress on the racial basis of European history, with which the name of Houston Stewart Chamberlain is associated, was going out of fashion even in Germany where it was introduced to give an appearance of scientific support to the position of the Junkers, and to bolster up the divine right of kingship. But that a writer in democratic America should give currency to these doctrines is passing strange." This review appears to be actuated by war-emotion.

In the *Unpopular Review* for October, 1917, we find a criticism directed against Mr. Grant's not giving greater credit to the French nation: "We are asked to believe that XIXth century democratic France was decadent; a glance at the roll of French fame for the last hundred years is sufficient reply. Perhaps Cuvier, Comte, Claude Bernard, Taine, Pasteur were all Teutons? Such an assertion in most cases is difficult to disprove. Renan, who was a believer in race, and a great admirer of Germany, gave his ethnic formula as "a Celto-Gascon mongrel, with a dash of Lappish blood" and added modestly: 'This ought to correspond to perfect imbecility.' Henri Poincare was a mathematician of rare genius; it is said that in the last years of his career he suffered from the solitude of the discoverer voyaging through strange seas of thought alone. We have a minute physiological description of him by Dr. Toulouse. This pioneer was an Alpine, a 'vile brachy'."

Such a paragraph illustrates very well the childish futility of attempting to settle generalizations in fields of history by citing a few instances. As a matter of fact, France has fallen behind during the last three generations very markedly in her production of scientists of international eminence as compared with England and Germany and quite beyond the expectation from changes in the total population. This assertion is based on statistical research the abstract of which was published in the *Psychological Bulletin,* February 15th, 1914.

A very unfavorable review appeared in *Vanity Fair* for October, 1918. It occupied a page and a half of this

popular journal. A large picture of Alexander Dumas appeared on one of the same pages—amusing coincidence. The writer of the review is an author of childrens' plays, literary essays, etc. He tells all who may wish to read that: "As for skull measurements the old-fashioned phrenologists dealt at least with Love, Ambition, Memory and other human qualities."

It appears from a review of reviews of this singularly provocative work, "The Passing of the Great Race," that the distinctly unfavorable criticisms were all published in other than scientific journals. Those in scientific journals were on the whole reasonably commendatory, though they did not regard it as a strictly scientific work. Favorable reviews appeared in the *New York Times* and also in the *Tribune*, January 13th, 1917; *Nation*, April 19th, 1917; *Nature* (London), August 23rd, 1917; the *Yale Review*, April, 1917; *Geographical Bulletin*, Philadelphia, July, 1917; the *American Historical Review*, July, 1917, was not unfriendly. "His endeavor to interpret history in terms of race is a legitimate and alluring enterprise, even if he goes rather far in claiming originality for the idea." "The book contains much solid scientific and historical truth." The *New York Sun*, April 7th, 1918, gave a very favorable review. "Get the book and read it; it's worth while." The *British Medical Journal*, August 18th, 1917, said: "While not prepared to go all the way with the author into the debatable region of practical engenics, we can commend his treatise to serious students."

In closing this too brief review, which is really more of an objective analysis of a book's reception, it is interesting to summarize the matter. Nearly all the reviews published in scientific journals or in the leading newspapers were either favorable or moderately favorable. The distinctly unfavorable were either important British reviews, which were apparently actuated by war-emotion, or were published in American newspapers and magazines and signed by persons of non-Nordic race.

Thinking upon all this has suggested to the present reviewer the following idea: Animosity against any pretentions of superiority on the part of members of one race over members of another merely on the ground of *race* is bound to bring about special and instantaneous resentment in nearly every instance. This is because a peculiar reaction takes place which is itself of evolutionary origin and of survival value, and has been a distinctly human trait ever since the species *Homo sapiens* began to differentiate from the other anthropoids. Men have evolved in group formation and men will resent an injury to the group, or fight for the group where they would not move a muscle on their own account. This principle is so strong that we often witness it as a sort of professional *ésprit de corps*. This makes it almost impossible to have a cold-blooded discussion of racial questions, or an objective classification of temperamental matters on which humanity in general will agree. It is too much a question of norms, too much a question of ultimate values.

This, however, does not prevent a good deal of reasonably accurate classification and tabulation of racial psychological differences. We may not be able to get agreement as to whether pure science or pure song be of the better worth, but it is possible to map geographically the origin of both science and song; and up to date a good deal has been done in the way of mapping racially the origin of science, both pure and applied, including administration faculties, success in business, war, and government. So far, the weights all fall tremendously to the credit of the Nordic race.

There can be no question that the Nordic race is and has been a superior one. Whether it is passing or not is a question. Perhaps future researches may make it possible to forecast these racial and historical problems.—

FREDERICK ADAMS WOODS.

# A FLORAL ABNORMALITY OF THE INDIAN WATER LILY

## Prolification and Phyllomorphy in Nymphaea Rubra

P. M. Debbarman
*Howra, India*

THE curious specimen described below appears to be worth placing on record as an example principally of axial floral prolification of the flower and phyllomorphy of the stamens.

In this specimen a small supernumerary flower with a distinct pedicel has issued from the axil of one of the inner petals of a normal-sized flower of *Nymphaea rubra Roxb.* The stamens have been transformed into small leaf-like structures thus exhibiting "phyllomorphy." This latter change is very striking in view of the fact that the structure of an anther is usually far removed from that of an ordinary leaf. The ovary has been found to be filled with a brownish-yellow mass and covered with intricate woolly hairs. No trace of any stamens or ovary has been found inside the supernumerary flower, which is quite small in comparison with normal flowers. Not only the flowers but even the leaves in this specimen are found to be rather modified in shape and size.

Masters has recorded a somewhat similar specimen of Nymphaea in his *Vegetable Teratology.* The present one, however, primarily differs from the latter in the following respects—(1) the scape is free from any sign of torsion; (2) the supernumerary flower has apparently proceeded from the axil of a petal; (3) long matted hairs cover the disc and the abortive ovary and (4) the leaves are modified in size and shape.

It seems quite probable that two different kinds of factors—one internal and the other external—might have been at work here, giving rise to these structural deviations. On the one hand the presence of the supernumerary flower and the change in the shape and size of the leaves lead us to suspect that these might have been due to some internal cause (e. g. nutrition), and, on the other hand, the abnormal tissue in the abortive ovary and the hairs on it, lead us to suspect some external factor (e. g. a parasite).

**LEAVES FROM STAMENS**

FIGURE 18. Several stamens have developed into small, leaf-like structures, and a supernumerary flower has grown from the axils of one of the petals. Leaves and stamens are structurally so different that such a change of characters is remarkable. It is not known what caused this variation, but it is believed to be due either to a parasite or to a nutritional disturbance.